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A model to improve the Evaluation and Selection of Public Contest's Candidates (Police Officers) based on AI technologies

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Dissertation

presented as partial requirement for obtaining the Master Degree Program in Data Science and Advanced Analytics

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
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A MODEL TO IMPROVE THE EVALUATION AND SELECTION OF PUBLIC CONTEST'S CANDIDATES (POLICE OFFICERS) BASED ON AI TECHNOLOGIES

by

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Dissertation presented as partial requirement for obtaining the Master's degree in Advanced Analytics, with a Specialization in Business Analytics

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledge the Rules of Conduct and Code of Honor from the NOVA Information Management School.

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ABSTRACT

The number of candidates applying to Public Contests is increasing compared to the number of Human Resources employees required for selecting them for Police Forces. This work intends to perceive how those Public Institutions can evaluate and select their candidates efficiently during the different phases of the recruitment process, and for achieving this purpose AI approaches will be studied. This paper presents two research questions and introduces a corresponding systematic literature review, focusing on AI technologies, so the reader is able to understand which are most used and more appropriate to be applied to Police Forces as a complementary recruitment strategy of the National Criminal Investigation Police agency of Portugal – *Polícia Judiciária*.

Design Science Research (DSR) was the methodological approach chosen. The suggestion of a theoretical framework is the main contribution of this study in pair with the segmentation of the candidates (future Criminal Inspectors). It also helped to comprehend the most important facts facing Public Institutions regarding the usage of AI technologies, to make decisions about evaluating and selecting candidates. Following the PRISMA methodology guidelines, a systematic literature review and meta-analyses method was adopted to identify how can the usage and exploitation of transparent AI have a positive impact on the recruitment process of a Public Institution, resulting in an analysis of 34 papers published between 2017 and 2021.

The AI-based theoretical framework, applicable within the analysis of literature papers, solves the problem of how the Institutions can gain insights about their candidates while profiling them; how to obtain more accurate information from the interview phase; and how to reach a more rigorous assessment of their emotional intelligence providing a better alignment of moral values. This way, this work aims to advise the improvement of the decision making to be taken by a recruiter of a Police Force Institution, turning it into a more automated and evidence-based decision when it comes to recruiting the adequate candidate for the place.

KEYWORDS

PUBLICATIONS RESULTING FROM THIS DISSERTATION

Gonçalves, M., Anastasiadou, M., & Santos, V. (2022). AI and Public Contests: A model to improve the Evaluation and Selection of Public Contest Candidates. Transforming Government: People, Process and Policy.

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LIST OF ABBREVIATIONS AND ACRONYMS

AI   Artificial Intelligence

DSR   Design Science Research

PJ   Polícia Judiciária (National Criminal Investigation Police agency of Portugal)

PRISMA   Preferred Reporting Items for Systematic Reviews and Meta-Analyses

SLR   Systematic Literature Review

1. INTRODUCTION

The purpose of this research is to contribute to a better understanding of AI and how AI technologies might innovate Public Contests, particularly in Police Forces, having the real example of the recruitment process in the National Criminal Investigation Police agency of Portugal – *Polícia Judiciária*. This chapter will discuss the context, motivation, objective, and respective organization followed in this research study.

1.1. CONTEXT

Highly specialized Public Institutions, like Police Forces, require a prolonged recruitment process composed of different evaluations to ensure that the most competent candidates are selected. The importance of being professional during those evaluations emerges with it, especially when applying for a new sensitive position. Even after the five evaluations that constitute the *Polícia Judiciária* recruitment process, as described in the third chapter (3.1.2. Identify and describe the phases that compose the recruitment process under the Ordinance n.º 248/2021), some doubts may remain on the recruiters' side, who need to ensure that they are doing the right option about contracting the candidate. Actually, it is more complex to assess values, principles, and soft skills than knowledge and hard skills (Allal-Chérif et al., 2021). This is where some AI technologies may have an impact and can be beneficial to link the gaps between the evaluation and selection of Public Contest candidates and the recruiter.

Even though the goal of this paper is to provide a broad overview of AI opportunities in Public Institutions, particularly in Police Forces, it does have some areas of focus covered in the theoretical framework. Initially, one suggestion regards profiling, in terms of sociodemographic variables, the candidates of the Public Contest. Another suggestion is to start conducting AI-assisted interviews that include facial emotion recognition while the interview is occurring. Additionally, the third proposal concerns the use of sentiment analysis techniques in social media after the interview phase. The recruiters look for more than just tracking photos, videos, or comments that were posted on social media, which usually are not made public, although they are recorded as well. It is important to be aware of the feelings and opinions that are expressed across the internet and on numerous social media, which leads to an increase in the number of user-generated sentences containing sentiment information that is crucial to analyze (Abd El-Jawad et al., 2018). For this one exist two noticeable approaches to text classification used for Sentiment Analysis: lexicon-based and machine learning (Dhaoui et al., 2017).

From an organizational perspective, they avoid relating with someone who does not share their culture and principles for fear of ruining their reputation, such as controversial or unethical behaviors, and these two suggestions can be beneficial in that way to take the necessary conclusions and consequently to ascertain a more complete picture of the candidate. This study aims to provide a pioneering effort in clarifying how AI can improve Public Contests and creates a theoretical framework based on the gaps in the evaluation and selection of candidates, pointed out by *Polícia Judiciária*, thus it can be applied to Police Forces as an additional recruitment strategy.

1.2. MOTIVATION

The development of a theoretical framework supported by the exploitation of AI technologies can benefit the Public Institutions, developing a closer relationship with the candidates. The public sector could obtain a lot from collecting citizens' knowledge and using it when developing their service. It becomes even more significant when public authorities use data-driven approaches, such as social media monitoring. Connections between transparency, openness, accountability, and trust are often nuclear (Hedestig et al., 2018). Data analytics allow the personalization of public service, so it helps to tailor public service delivery according to individual needs (van Veenstra et al., 2020).

It is known that recruiters regularly consult the profiles on social networks of candidates they plan to recruit, which highlights the need for candidates to be vigilant about their content once each element can be considered to recruit or dismiss them. Indeed, it is easy for individuals to ruin their reputations by misusing social networks (Allal-Chérif et al., 2021). The manual and tedious task of consulting through the social media accounts of the candidate and discovering more about their content is feasible in case the number of candidates does not exceed the dozens, although that seems unrealistic when talking about Public Contests, where usually the number of candidates exceeds the hundreds. For supporting this purpose, the use of AI will be valuable to accelerate, improve, and get rid of human errors (Wirtz et al., 2020) during a selection phase because it will browse through the social networks, increase the data available for analysis and help the Human Resources team to handle the applicant funnel (Laurim et al., 2021). Applying these techniques will allow the prediction of someone's opinion and understanding their system of beliefs and ideology, taking into account their speech, for example, on social, economic, environmental, and cultural factors (Hassani et al., 2020).

In any recruitment process, the goal is to find the candidate who fits the organization's culture guaranteeing that he is the proper person for the role. Considering that the recruitment process is no longer about selecting talented persons but rather capturing them and ensuring their loyalty, which is essential for social businesses' durability and long-term vision (Allal-Chérif et al., 2021). Moreover, the recruiter needs to understand the facial expressions that undercover the corresponding emotions and be able to perceive the personality traits of the candidates (Song, 2021). These usually are obtained through an interview, but AI also grows in that area, and AI-assisted interviews are a convenient option for supporting that purpose.

Towards understanding the perception of candidates from the Criminal Inspector PJ course 2019, from age and gender-related perspectives, in terms of the subjects that will be further discussed – such as social media analysis and its content, AI, and Sentiment Analysis thematic - an online survey was conducted (attached in the eighth chapter – Appendix).

The survey had 76 answers, although five were not considered because they were not from the Criminal Inspector *Polícia Judiciária* course 2019. As well as another three replies were excluded because the applicants were not registered on any social media platform.

After selecting the data, it is possible to infer that 34 women and 34 men answered, and their most common age group is between 27 and 30 years old. Furthermore, 47 candidates mentioned they are registered on Facebook and Instagram, nevertheless only 14 recognize themselves as active users (divided into nine women and five men), which means they comment, post, or share content regularly.

In terms of the type of content, sports, travel, and culture belong to the top 3 contents that the candidates are more aware of and interested in. Regarding the time spent daily on social media, most women and men between 27-30 years old tend to spend one hour per day on it.

Concerning the content of social media and if it should be taken into account in the recruitment process of the candidates, 39 agree with the topic against 29 candidates. Notice that among the women who have 27-30 years old, 11 are against that checking phase, while within the same age group, 14 men are in favour. The candidates in favour refer that it should be taken into account to rule out habits or routines that disagree with the discreet posture that should guide the way of behaving of the investigator and also that according to the internal security law, the candidate must be non-partisan, so militant candidates from political parties must be avoided. Thus, it might help define the criterion of the person's socialization. While the opposition pointed out problems related to privacy and that it might not reflect the authentic values of someone. Independently of thinking that is a relevant approach, many agreed that it should not only be based on that information or being an exclusion criterion but instead be seen from a complementary perspective.

Only four candidates participated in a recruitment process associated with AI. They described the experience as satisfactory, fair, and pleasant.

Concerning the sentiment analysis field, 44 candidates answered they were against that application, while 24 favoured it. Notice that more men are in favour than women. 20 applicants admit that adopting the sentiment analysis technique in the recruitment process would be free of bias, and it possible will allow a more objective selection, taking into account the specific profile of the candidate. Hence, the benefits can outweigh the costs if the process is carefully studied. On the other hand, 22 men and 26 women believe it is not free of bias once AI still suffers from shortcomings that would not allow the process to be completely impartial, namely by misinterpretations of certain contents.

To summarize, more than half part of the candidates for the Criminal Inspector PJ course 2019, precisely 68, are registered on a social media platform. 39 candidates agree that the content of social media should be taken into consideration in the recruitment process, although it should not be seen as an exclusion criterion. When it comes to the sentiment analysis topic, 44 candidates disagree with its application since AI might promote bias. This way, this dissertation intends to demonstrate on the contrary how sentiment analysis can be applied in an automated and transparent manner through AI models.

The models suggested accomplishing the desired goal will need to represent transparency, allowing high-quality, fair, and reliable decisions. Applying this transparency to the candidates enables them to receive information for the justification of the decision (Why did we decide to not hire the candidate?) as well as details on who holds responsibility for the said decision, increasing the trust in the built algorithm (de Fine Licht & de Fine Licht, 2020). In the end, the possible positive outcomes, besides the quality and trust of the candidates, are the improvement of the Institution's reputation that start applying transparent and automated evidence-based decision-making, and the lack of credibility of the future employees decreases.

The research goal will be to explore AI strategies in order to assess Police Forces Public Contests and reduce the likelihood of hiring inadequate candidates who demonstrate unethical behaviors to serve society. At the same time, suggesting a new phase with some new assessments in the recruitment

process. In the end, it will contribute to hiring highly consistent, accountable, and transparent Criminal Inspectors. To achieve this purpose, two research questions were formulated:

- RQ1: "What are the most important facts facing Public Institutions regarding the usage of AI technologies to make decisions about evaluating and selecting candidates?"
- RQ2: "How can the usage and exploitation of transparent AI have a positive impact on the recruitment process of a Public Institution?".

Primarily is necessary to understand the existing gaps in the selection criteria of the Public Contests that are in vigor in Police Forces, specifically in *Polícia Judiciária*, as well as define a segmentation based on sociodemographic characteristics of the future Criminal Inspectors according to the provided dataset (age, gender, nationality, education level, study area, and place of living). After it, it is relevant to discuss AI strategies, either lexicon-based or machine learning, to develop an innovative theoretical framework. Compounding the answers to both research questions might help the Police to fulfill the gap related to profiling the candidates; obtain more accurate information from the interview phase; and help the recruiter choose the most correct technique to deduce new insights about a candidate who has a social media profile and to gauge a more complete picture of the candidate. Finally, evaluate through interviews with experts how these strategies can fit in the previous process, so how prone are the Police Forces currently to implement it in a new phase (suggesting a TO-BE model) and use this type of technology.

1.3. OBJECTIVE

This study aims to construct an innovative and AI-based theoretical framework for the recruitment process of a Police Force Institution and is suitable to be applied in *Polícia Judiciária*.

This suggestion will contribute to employing future Criminal Inspectors that are straightforward, professional, transparent, and present ethical and deontological principles aligned with the values of the Institution.

1.4. THESIS ORGANIZATION

The paper organization follows the DSR approach once it was the methodology selected to discover and identify problems relevant to the evaluation and selection of candidates in a Police Force recruitment process. The designed final artifact will pair those problems with the appropriate AI technologies, resulting in a new or improved AI-based theoretical framework. Initially, the DSR methodology is deeply studied, and the reasons behind that choice are described as well as the data collected for achieving the principal purpose. The third chapter, the Portuguese Criminal Investigation Police, studies the context in detail through interviews with experts, meaning the business needs that emerge from the environment and are relevant to the development of the research. Then the adopted SLR technique (PRISMA) and the methodology behind it, the application of PRISMA, and the results using the VOSviewer tool are explained. The findings that arise with the SLR, aligned with both research questions, are exposed in the discussion. The last chapter elaborates on the proposed artifact evaluated and validated by the experts. The theoretical framework will be explained, and the conclusions taken after performing the segmentation of the candidates.

2. METHODOLOGY

In this study, DSR is the methodological approach used to connect and pair relevant challenges in the recruitment processes of Police Forces with AI tools that might reveal the potential for purposes related to those challenges. Three studies employ this type of paradigm (Anastasiadou, 2019; Anastasiadou et al., 2021; Rosenberger et al., 2017), as described in Table 7. Since it is a problem-solving paradigm, it tries to create a designed final artifact or solution to a precise problem (Anastasiadou, 2019).

2.1. DESIGN SCIENCE RESEARCH

The framework (Figure 1) is used to place and compare paradigms. Behavioral-science and design-science paradigms are combined to create a conceptual framework for understanding, implementing, and evaluating IS research and they are two complementary phases (*Design Science in Information Systems Research*, 2021). The purpose of behavioral science research is the truth, therefore, it advises the design. The design's purpose of scientific research is utility since it serves practical use and advises the theory.
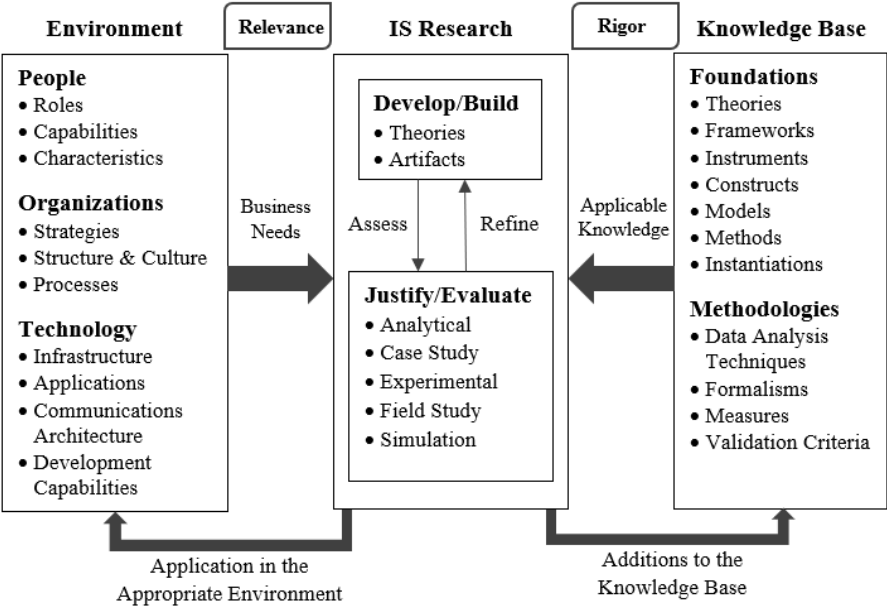
Figure 1 - DRS Framework (Design Science in Information Systems Research, 2021)

The issue space in which the phenomena of interest reside is defined by the environment. People, organizations, and their existing or planned technologies constitute IS research. It contains the goals, tasks, issues, and opportunities that characterize the business needs as they are experienced by people within the organization. Organizational strategies, structure, culture, and existing business processes are all considered while assessing and evaluating business needs. They are placed concerning current technology infrastructure, applications, communication structures, and development capabilities. Together, they define the researcher's perception of the business need. Research relevance is ensured

by framing research operations to address business needs (*Design Science in Information Systems Research*, 2021).

In the IS research, research assessment through the justify/evaluate processes might lead to the discovery of defects in the theory or artifact, necessitating refinement and reassessment. Future research directions usually defined the refinement and reassessment process (*Design Science in Information Systems Research*, 2021).

The knowledge base provides the raw materials for IS research to be carried out from and through. The foundations and methodologies produce the knowledge base. Foundational theories, frameworks, instruments, constructs, models, methods, and instantiations employed in the develop/build phase of a research study come from prior IS research and outcomes from reference disciplines. Methodologies offer guidelines that are employed in the justify/evaluate process. Rigor is produced through the proper application of established foundations and methodologies (*Design Science in Information Systems Research*, 2021).

The seven guidelines are based on the core premise of design-science research. The knowledge and comprehension of a design problem and its solution are acquired in the building and artifact application (*Design Science in Information Systems Research*, 2021). The first guideline, Design as an Artifact, says that exist four types of artifacts: the constructs incorporate central concepts and the symbols for describing phenomena; the models are built on constructs and demonstrate their relationships and dependencies; the methods characterize the activities, the algorithms, and the techniques for achieving specific goals (Rosenberger et al., 2017); and the instantiations demonstrate the usefulness of the design process and the product under design, it may be in the form of an intellectual or software tool for improving the information system development process (*Design Science in Information Systems Research*, 2021). The other six guidelines (*Design Science in Information Systems Research*, 2021) are:

- Problem Relevance: DSR aims to create technology-based solutions to critical and relevant business problems;
- Design Evaluation: a design artifact's utility, quality, and efficacy must be rigorously demonstrated through well-executed evaluation techniques;
- Research Contributions: effective DSR must contribute to the design artifact, design foundations, and/or design processes in a clear and verifiable way;
- Research Rigor: in both the development and evaluation of the design artifact, DSR relies on the use of rigorous techniques;
- Design as a Search Process: the search for an appropriate artifact necessitates the use of available process tools to achieve desired outcomes while complying with the problem environment's laws;
- Communication of Research: DSR must be effectively communicated to both technology and management-oriented audiences.

According to another research paper that follows Peffers's DSR research method, but with different process models, six activities are involved in all process. It starts with the problem identification and motivation; after it defines the objectives that develop a suggestion for the challenge-solving artifact;

up next the design and development; the fourth activity is the demonstration; the fifth is the evaluation; and finally the communication of the artifact (Rosenberger et al., 2017).

The DSR goal is to increase the knowledge of a specific domain through an iteration process that begins with a research question and then proceeds with a line of construction, evaluation, and redesign of artifacts (Anastasiadou et al., 2021).

The main benefit of this methodology is the design and redesign process of artifacts that help expand the understanding of a challenge solving it or contributing to a better solution (Anastasiadou et al., 2021). The continuous re-evaluation process assesses in loops until a solution is finally elected, so it tends to promote the quality of the final design (Anastasiadou et al., 2021).

As can be seen, Hevner's DSR research process model (Figure 1) was adapted and is followed in this study once it represents a more practical-based process and focuses on real-world problems in an actual environment (fully described in the third chapter) (Anastasiadou, 2019).

2.2. RESEARCH STRATEGY

In this study, the artifact consists of a framework that fits the "model" definition. It is constructed with conceptual pairs to discover and identify relevant problems in the evaluation and selection of candidates in the recruitment process. The result is a new or improved AI conceptual framework that pairs them with the compatible algorithms.
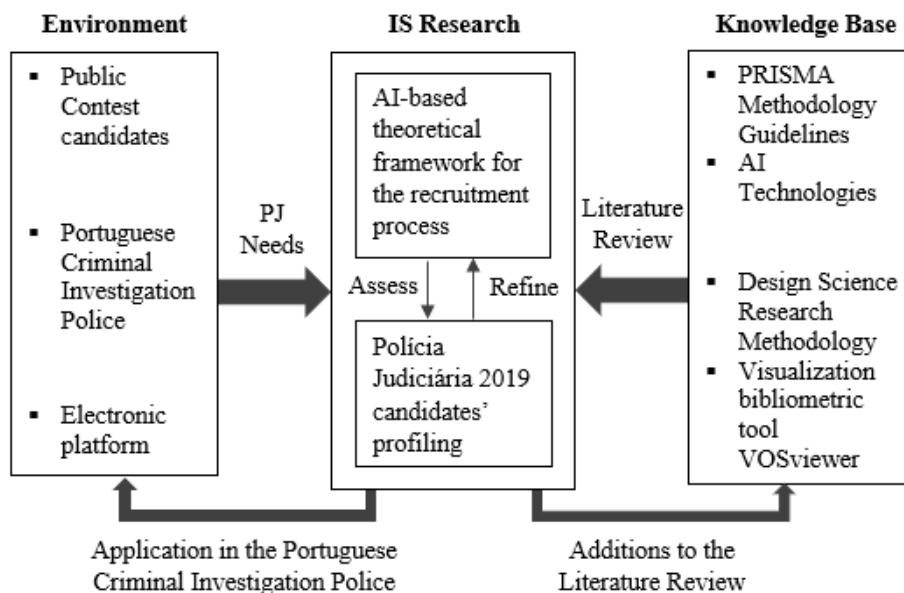
Figure 2 - DSR applied to the context

The figure above (Figure 2) illustrates the DSR instantiation applied to this particular research. In the first phase, the environment and the literature review are explained. The third chapter will be crucial to understand the context, conditions and needs, the employees, and the technology employed there from an organizational perspective, the Portuguese Criminal Investigation Police. The focus is on the

candidates that apply to the National Public Contest and the Police will manage their applications initially through an electronic platform. Regarding the literature review, the fourth chapter will provide the background for the initial framework proposal once it is based on obtaining what is previously known in the research area about a specific field and getting expertise on it. It is achieved while reading and understanding the work of other researchers in the same field (Anastasiadou, 2019). In this context, our study adopts a well-established systematic literature review (SLR) method that follows PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Moher et al., 2009). It helped identify the most pertinent literature contributions to suggest the most modern AI technologies likely to be implemented in the context, for example, predicting the sentiment on social media texts using machine learning or lexicon-based techniques. This review included readings related to AI, social media, sentiment analysis, statistical techniques, and theoretical concepts about the recruitment process in the Public Sector, including transparency. Moreover, the visualization bibliometric tool VOSviewer was experimented to find the most occurrences in terms of keywords, authors, and title and abstract text in the literature (*VOSviewer - Visualizing Scientific Landscapes*, n.d.).

In a second phase, the objectives will be defined, and the development will be described, which means the IS research background. First, compare and categorize AI technology techniques according to the ones found while performing the SLR. Secondly, create a paired AI conceptual framework to characterize and outline each gap found in the evaluation and selection of the *Polícia Judiciária* recruitment process. Each AI technology will create a typology between the problems found and the corresponding solution.

The next phase corresponds to the data collection. This study was obtained through a comprehensive literature review and interviews with experts of *Polícia Judiciária*. The literature review helped define the AI technologies, for instance, machine learning techniques, to be applied as a complementary hiring strategy at the beginning and in the last phase of the Public Contest recruitment process. This resulted in the creation of the paired AI conceptual framework (artifact) presented in the last chapter. For the interviews, the semi-structured questions prepared and asked are explained in the third chapter, and the order in which the questions were asked was determined by the conversation's flow.

Relatively to the data analysis, on one hand, the type of data collected is qualitative data with non-numeric data or no quantified data. On the other hand, quantitative data is also collected for performing clusters. According to Saunders (Anastasiadou, 2019), the collected data can be divided into three processes: summarizing of meaning, categorization of meaning, and structuring of meaning using a narrative. The first process, summarizing of meaning, refers to the data that needs to be transcribed and summarized after the expert is listened to and recorded, as it is done in the third chapter. The categorization of the meaning process consists in creating categories and attaching those categories in a meaningful way to the data. The structuring of meaning using a narrative process resides in extracting meaning from the data and reaching a conclusion to support the analysis, for instance noting patterns, themes or clustering (Anastasiadou, 2019). Considering this last process, a segmentation will be elaborated with the quantitative dataset (age, gender, nationality, education level, study area, and place of living) provided by *Polícia Judiciária* related to the candidates of the last Public Contest held in 2019. The results of this segmentation are shown in the fifth chapter (5.4. Segmentation of the Public Contest Candidate's held in 2019).

In the next phase, the evaluation, semi-structured interviews will be conducted with experts of *Polícia Judiciária*. The main goal of these interviews is to evaluate and validate the conceptual framework (artifact). It will represent the typology between the problems associated with the evaluation and selection of candidates during the recruitment process and the corresponding AI technologies solutions.

Finally, the sum up is presented, the results of this study are elaborated on, and the limitations analyzed.

3. PORTUGUESE CRIMINAL INVESTIGATION POLICE

According to Hevner (*Design Science in Information Systems Research*, 2021), the environment represents the understanding of the context and conditions in terms of the people, the organization, and the technology (Figure 1). Considering this, a theory that is not useful for the environment does not contribute much to the literature.

3.1. RECRUITMENT REQUIREMENTS AND PROCESS

This chapter will emphasize the requirements and needs of *Polícia Judiciária* (PJ) (*Polícia Judiciária*, n.d.), where the mission is to assist the judicial and prosecuting authorities in criminal investigations with national strategies. Two semi-structured interviews were fundamental to gather the necessary knowledge, one in the presence of the National Director Advisor and another one where the President of the Jury attended. Both helped answer the following questions.

3.1.1. Clarify the recruitment requirements in *Polícia Judiciária*

The general recruitment requirements in any PJ career under the Decree-Law No. 138/2019 Article 44.º (*Decreto-Lei n.º 138/2019 | DRE*, n.d.) are: possess Portuguese nationality, when not released by the Constitution, by international convention, or by special law; hold the academic qualifications required for the job or position; absence of a criminal record; physical robustness and psychological profile essential to the exercise of functions; non-inhibition of the prosecution of public functions or non-interdiction for the prosecution of those it proposes to perform; compliance with mandatory vaccination laws. Relatively to the specific recruitment requirements in criminal investigation and security careers, are: have no more than 30 years old at the date of opening of the public contest; to employees already with a legal bond of public employment for an indefinite period, in the modalities of employment contract in public functions or appointment, the requirement provided immediately before is not applicable in this case, the age limit is set at 35 years; not being covered by the status of conscientious objector. Specific requirements for presenting in especial PJ careers are ownership of a light vehicle driving license and approval in a specific training course given at the IPJCC (Instituto da Polícia Judiciária e Ciências Criminais).

In terms of the regulation of the physical tests, thoroughly described in the Normative Order n.º 31/2001 (*Despacho Normativo n.º 31/2001 | DRE*, n.d.), the execution of the following exercises is necessary: coordination route; flexibility; long jump without balance; illinois (travel a distance of 60 meters, with several inversions of direction along the path); arm push-ups and extensions; abdominals; and running 2400 meters. The exercises are classified with annotation of able and not able.

In terms of the psychological examination, psychological characteristics and skills are evaluated, the manifestation of professional skills for entry into special careers involves the mobilization of skills and personality traits. Two types of assessments are:

- the evaluation of general competencies: the skills (logical-inductive reasoning; verbal critical reasoning; and numerical critical reasoning and concentrated attention); and the

personality traits (relationships with people; thinking style; feelings and emotions; neuroticism, extraversion, and openness to experience; kindness; and conscientiousness);

- the evaluation of specific skills: resistance to routine; resistance to frustration; ability to observe with particular attention to detail; ability to work in a team; oral and written communication skills; ability to handle statistical data; ability to respond quickly to stimuli; stress management capacity and general adaptability; and moral development (ethics of responsibility).

In terms of the medical examination, thoroughly described in the Normative Order n.º 31/2001 (*Despacho Normativo n.º 31/2001 | DRE*, n.d.), the following parameters will be evaluated: biometrics (male candidates who have between 1.60 m and maximum 1.95 m height; female candidates who have between 1.50 m and maximum 1.85 m height; and the weight-height relationship is also verified using a biometric table); visual acuity; hearing acuity; clinical observation; and complementary diagnostic tests.

3.1.2. Identify and describe the phases that compose the recruitment process under the Ordinance n.º 248/2021 (*Portaria n.º 248/2021 | DRE*, n.d.)

The candidates are aware of the opening public contest from the moment that Diário da República (DRE), Bolsa de Emprego Público (BEP), and the *Polícia Judiciária* (PJ) website announce it to the public as well as the conditions and requirements described above (Chapter II, Article 19.º), that the candidates need to satisfy in order to proceed into the next phase. The National Director establishes, in the respective act authorizing the contest procedure, a deadline for the submission of the applications, with a minimum of 10 and a maximum of 20 working days from the date of publication of the notice (Chapter II, Article 26.º). For the submission of the application to the competitive admission procedure, the payment of a contribution with the cost of the procedure is necessary (Chapter II, Article 27.º).

The recruitment process for a Police Force contest, specific for PJ, is composed of five selection methods that ensure a triage since all are knockout phases (Chapter II, Article 13.º). The Human Resources department starts receiving the registrations that have attached the necessary documents through the existing electronic platform, the only way the applications are formalized (Chapter II, Article 27.º). After it, the same department verifies for each candidate if the requirements are in coherence with the established. According to that, the Jury will assemble and formulate the admitted and non-admitted candidates' list. The announcement of that list is available at DRE and on the PJ website. The Human Resources department is in charge of receiving the candidates' reclamations about the results because the candidate has the chance of arguing or adding a missing document within 10 working days. The Jury is now able to ascertain who are the candidates who fulfil the requirements (some of them can be repechage). If the candidate does not fulfil the requirements the recruitment process stops there and is cancelled. Otherwise, the candidate will proceed to the next phase.

PJ evaluates the technical competence of candidates through declared examinations. The Jury prepares the written theoretical exam, to test academic and/or professional knowledge, technical skills, and the candidate's ability to apply them to hypothetical or concrete situations in the exercise of the function; and also prepares the respective answers. It was mentioned that the written theoretical exam could not have the name of the candidate anywhere, so it includes instead an identifier that is associated with a specific candidate. This way the integrity and confidentiality of the exam are proved and is not possible to favour anyone or bias the result. Then, the Jury executes the approved and non-approved candidates' list (with a 9.5 as the minimum grade). The announcement of that list and the remaining four lists with the results of the selection methods are available at the PJ facilities and available on its website or Intranet, in cases of promotion contest (Chapter II, Article 34.º). For this exam, a scale from 0 to 20 values is adopted, considering the valuation up to the hundredths (Chapter II, Article 13.º). The Human Resources department will publish the evaluation grid. Once again, the candidate has the opportunity of requesting a review of the obtained grade that will be analysed if presented a justification and prior payment of twenty euros fee (Chapter II, Article 6.º). The Jury is now able to ascertain whether the candidates achieved the minimum grade or not. If the candidate does not achieve the minimum grade the recruitment process stops there and is cancelled. Otherwise, the candidate will be notified by email by the Human Resources department about the following evaluation (including details about the place, the date, the time, and the material- Chapter II, Article 32.º). It is allowed to justifiably miss the tests, except for the written theoretical exam, with only a single possibility (Chapter I, Article 16.º).

Then in the IPJCC, the physical evaluation is done by 80 candidates per day, and the Jury executes the approved and non-approved candidates' list and sends it to the Human Resources department. The physical tests are evaluated through the classifications of Able and Not Able (Chapter II, Article 13.º). If the candidate does not pass the physical exam, the recruitment process stops there and is cancelled. Otherwise, the candidate will be notified by the Human Resources department about the following evaluation.

In the IPJCC, the Psychology and Selection Department will make a psychological evaluation composed of two phases (psycho technical and psychological certified exams- Chapter II, Article 7.º). The Jury then elaborates the approved and non-approved candidates' list. Psychological assessment is valued through the classifications of Able and Not Able, including the first phase of the method when entering a career in a criminal investigation (Chapter II, Article 13.º). If the candidate does not pass in the phycological evaluation the recruitment process stops there and is cancelled. Otherwise, the candidate will be notified by the Human Resources department about the following evaluation.

The next phase is done by an external medical entity specifically contracted for that purpose, so they do the medical evaluation, and the Jury then elaborates the approved and non-approved candidates' list. This examination is evaluated through the classifications of Able and Not Able (Chapter II, Article 13.º). If the candidate does not pass in medical evaluation the recruitment process stops there and is cancelled. Otherwise, the candidate will be notified by the Human Resources department about the following evaluation.

And finally, after succeeding in all the previous four evaluations, the last phase is an interview in the presence of the Juris. The professional interview aims to obtain information about behaviours, directly

related to the skills considered essential for the exercise of the function and other behavioural aspects of the candidates, namely those related to communication and interpersonal skills (Chapter II, Article 10.º). The jury is composed in an odd number, of a minimum of three actual members, one of whom presides, and two are surrogates (Chapter II, Article 21.º). For this exam, a scale from 0 to 20 values is adopted, considering the valuation up to the hundredths (Chapter II, Article 13.º). Being successful in all those five phases does not necessarily mean that the candidate will start the internship course because the places may be less than the number of candidates. In this case, the final ranking of candidates who complete the procedure, with approval in all applied selection methods, is carried out in descending order of the weighted arithmetic average of the quantitative classifications obtained in each selection method, expressed on a scale from 0 to 20 values, up to hundredths (Chapter II, Article 35.º). If the candidate has a position guaranteed, the Human Resources department will notify the candidate for signing the formation course contract, and the recruitment process finishes there.

As we can see, there is always a direct interaction through all the phases between the Jury and the Human Resources department.

To sum up, the candidate is excluded from the competition in the situations provided for in this ordinance, at any time, in particular, when: does not meet the admission requirements; presents false documents or omits relevant elements; obtains a grade fewer than 9.5 values or Not Able; does not present himself on the day and time indicated for the performance of one of the selection methods, under the terms set out in paragraph 5 of article 16; or expressly declares in writing to withdraw from the procedure (Chapter II, Article 33.º).

The table below (Table 1) describes the type of data that is collected along with the five phases of the recruitment process, according to the expert. It was also mentioned that the data collected in the 3rd phase of evaluation, psychological evaluation, is from now on qualitative data, though until then was quantitative.

Table 1 – Data collection type

Phase	Data type
1st phase	Quantitative data
2nd phase	Qualitative data
3rd phase	Qualitative data
4th phase	Qualitative data
5th phase	Quantitative data

3.2. AS-IS MODEL

The figures below (Figures 3 - 8) represent the AS-IS model, which is a descriptive model, of the current recruitment process from a single candidate perspective. Bizagi Modeler was the software used for creating the AS-IS diagrams in this study. The Bizagi Modeler (*Bizagi, One Platform; Every Process. User Guide Modeler*, n.d.) is a tool for visualizing, modelling, documenting, and simulating business processes in industry-standard BPMN 2.0 (Business Process Model and Notation). BPMN is a graphical notation created to provide a unified language of worldwide acceptance, this means that this standard graphical notation expresses the logic of steps in a business process, in this specific context, the recruitment process followed by *Polícia Judiciária*. This notation has been especially designed to coordinate the sequence of processes and messages that flow between participants in different activities (*Bizagi, One Platform; Every Process. User Guide Modeler*, n.d.).

3.2.1. Process "Check the general and specific requirements" – AS-IS Diagram

The process "Check the general and specific requirements" (Figure 3) is performed by the DRE, BEP, and the PJ website for the announcement of the requirements and then the results, respectively. The HR department and the Jury are two other actors involved in this process.
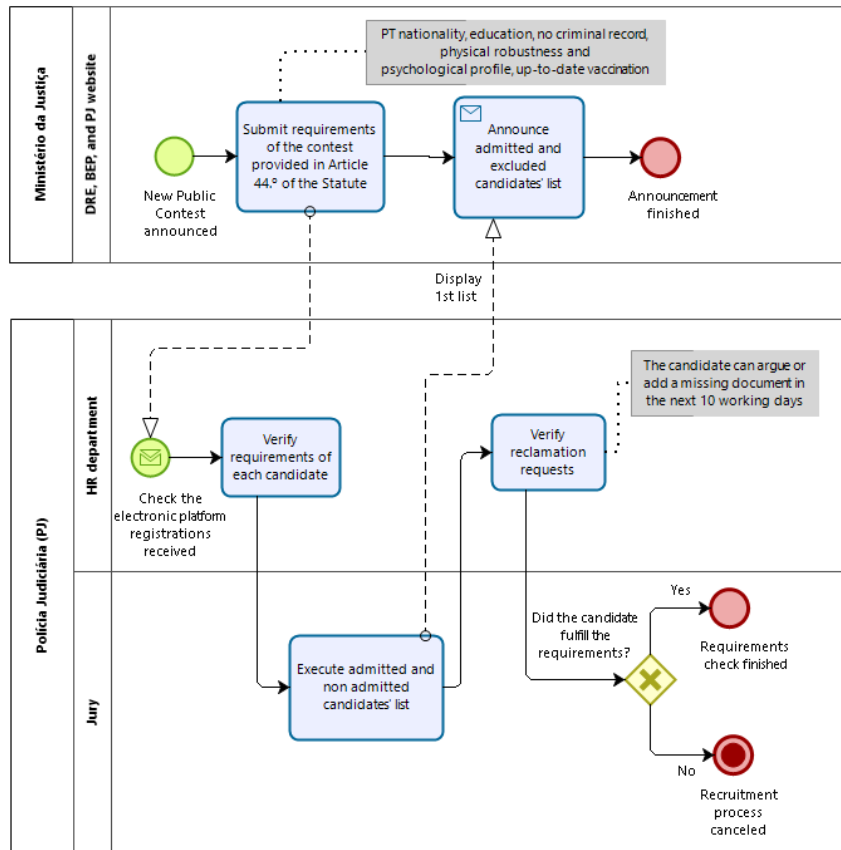
Figure 3 - Check the general and specific requirements – AS-IS Diagram

3.2.2. Process "1st phase of the recruitment process" – AS-IS Diagram

The process "1st phase of the recruitment process" (Figure 4) is performed by the Jury and the HR department. The candidates' list is published on the PJ facilities and their website.
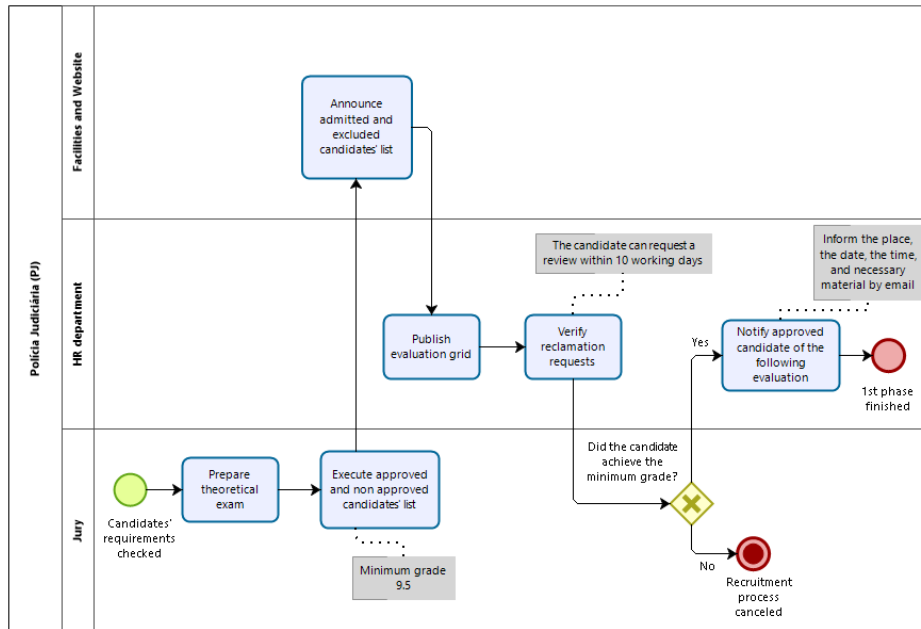
Figure 4 - 1st phase (theoretical exam) – AS-IS Diagram

3.2.3. Process "2ⁿᵈ phase of the recruitment process" – AS-IS Diagram

The process "2ⁿᵈ phase of the recruitment process" (Figure 5) is performed by the Jury and the HR department. The candidates' list is published on the PJ facilities and their website.
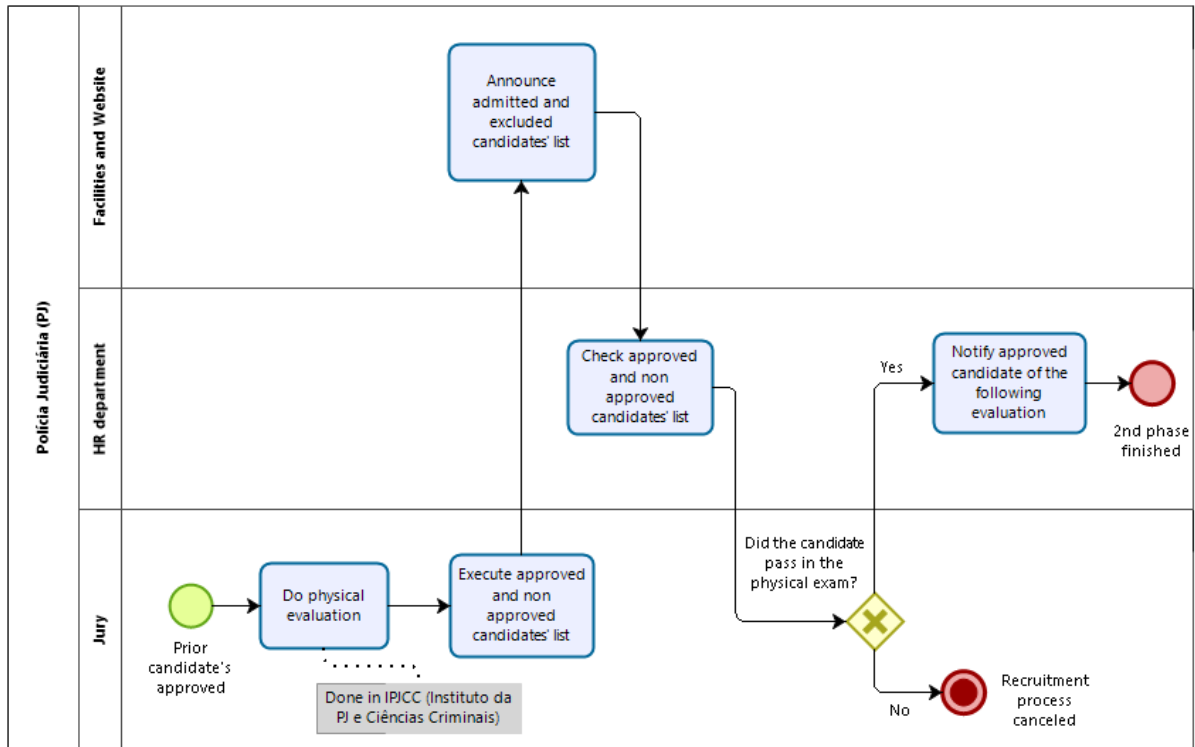
Figure 5 - 2ⁿᵈ phase (physical evaluation) – AS-IS Diagram

3.2.4. Process "3ʳᵈ phase of the recruitment process" – AS-IS Diagram

The process "3ʳᵈ phase of the recruitment process" (Figure 6) is performed by the Psychology and Selection department, the Jury, and the HR department. The candidates' list is published on the PJ facilities and their website.
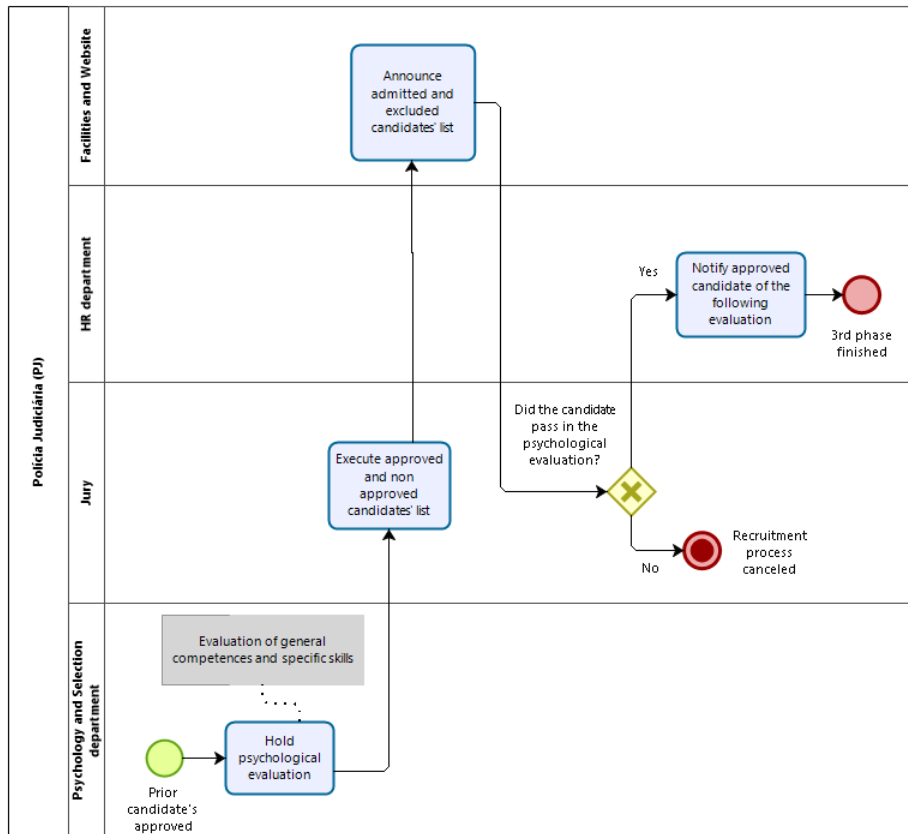
Figure 6 - 3ʳᵈ phase (psychological evaluation) – AS-IS Diagram

3.2.5. Process "4th phase of the recruitment process" – AS-IS Diagram

The process "4th phase of the recruitment process" (Figure 7) is performed by the Doctor (externally contracted), the Jury, and the HR department. The candidates' list is published on the PJ facilities and their website.
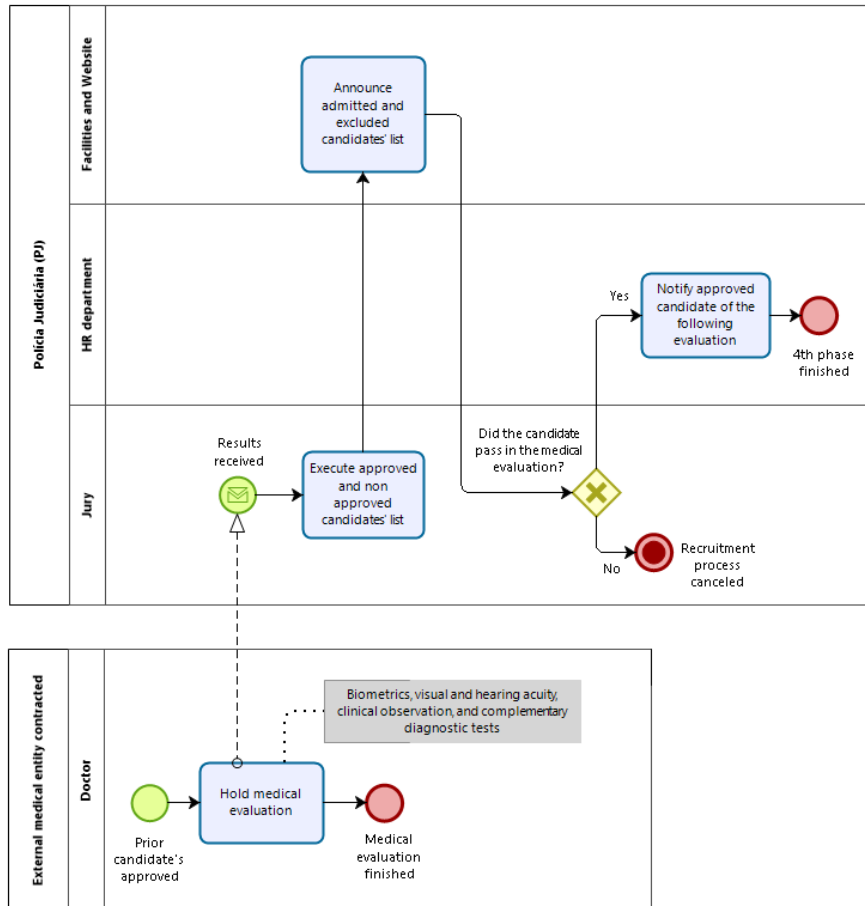
Figure 7 - 4th phase (medical evaluation) – AS-IS Diagram

3.2.6. Process "5th phase of the recruitment process" – AS-IS Diagram

The process "5th phase of the recruitment process" (Figure 8) constitutes the final phase of the recruitment process and is performed by the Jury and the HR department. The candidates' list is published on the PJ facilities and their website.
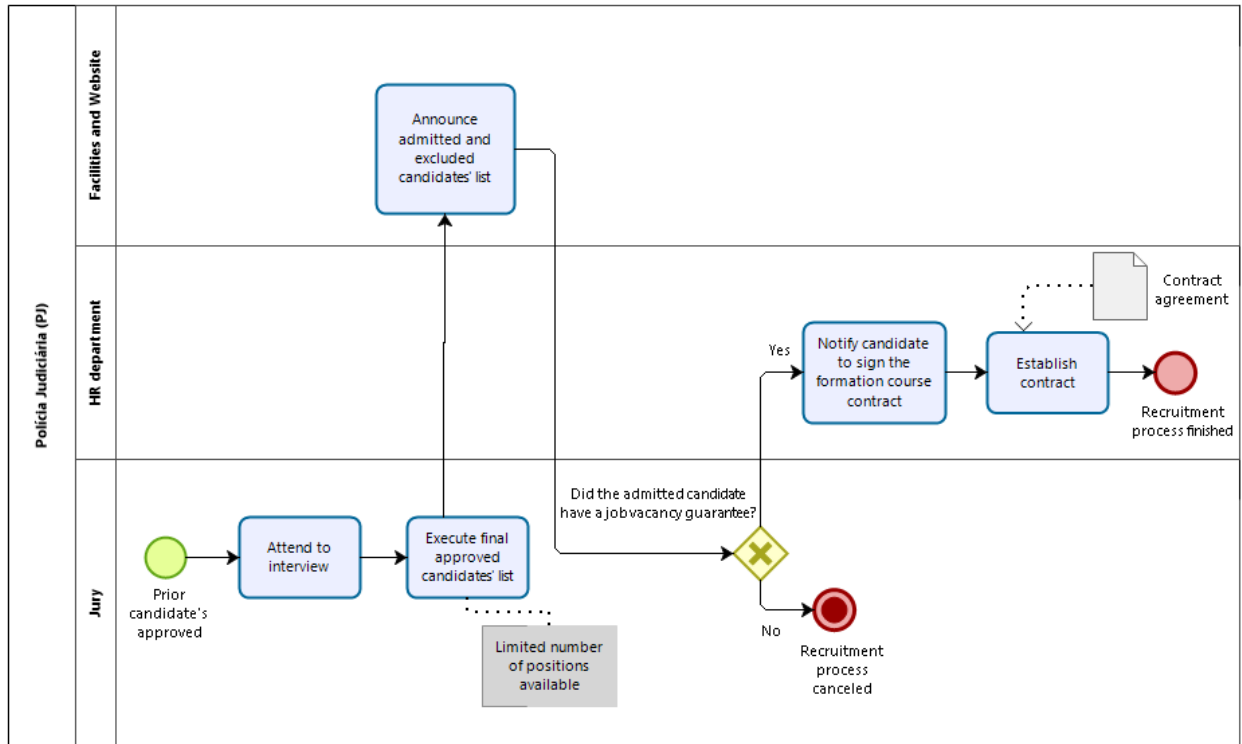
Figure 8 - 5th phase (interview) – AS-IS Diagram

3.3. AI AS A NEW PHASE IN THE RECRUITMENT PROCESS

3.3.1. Identify the gaps associated with those phases

Two gaps were identified and have no current solution. The first one is associated with the electronic platform that receives all the candidates' applications. Nonetheless, the platform was not developed to follow the entire process from the beginning until the end. It only generates an excel list after receiving the applications, and the rest of the information needs to be treated by paper and email, so there is a lack of automation associated with the information system. The second gap, pointed out by the President of the Jury, is related to the reduced number of internal human resources workers that cannot manage efficiently all the processed work delivered to them.

3.3.2. Integrate a new procedure into the current recruitment strategy

In the TO-BE model, a prescriptive modelling of the future recruitment process for a single candidate, exists two steps where AI can be implemented according to the expert suggestions either in the psychological examination or in the final interview. Consequently, the model includes a lane regarding the Applicant Tracking System and the AI Tracking system step utilized for, respectively:

- the screening stage, this way the entire analysis of the requirements (all the documentation that is asked by the Institution) would be accelerated, and the human errors diminished;
- the second system for the interview within facial recognition in order to discover more about non-verbal communication. According to Interpol, this technique is "Coupled with an automated biometric software application, this system is capable of identifying or verifying a person by comparing and analysing patterns, shapes and proportions of their facial features and contours." (Facial Recognition, n.d.);
- and for the implementation of a sentiment analysis technique at the end of the process, as a hypothesis in the case under Portuguese Law it is considered legal.

This redesign of the TO-BE model (5.5. Use Case) at a process level followed the Heuristic 9 – Process Automation (Dumas et al., 2013). This heuristic was selected to be applied to the data sharing of PJ (intranets and packaged enterprise systems) towards increasing the availability of information to improve visibility and decision-making.

This way, the devil's quadrangle results when applying this heuristic (Dumas et al., 2013) are:

- the processing time improves;
- the cost and the quality parameters are ambiguous, given that technology is initially expensive, it requires additional investment, although with the continuation of the use it will save the processing costs, and if well developed and applied, the defect rate will improve as well;

- the run time flexibility worsens in case the options offered by the technology do not cover all the relevant functionalities required.

3.3.3. Number of candidates that applied to the last National Public Contest

Approximately 2400 candidates concurred to the last Public Contest for Criminal Inspectors at PJ held from 2019 until 2021, although only 100 were accepted after succeeding in all five phases of the recruitment process. It was also mentioned that 200 candidates were excluded because they did not comply with the initial requirements, and 600 candidates did not attend the written theoretical exam.

3.3.4. Technique applied for the manual verification of the candidates

The expert referred in the interview that this process of monitorization of the candidates' social media in order to obtain more insights is illegal in Portugal, this way the PJ does not practice it.

Nevertheless, after further research into the legal aspects covered by General Data Privacy Regulation (GDPR) compliance guidelines (Radley-Gardner et al., 2016), the Portuguese Labour Code (*Lei n.º 7/2009 - Diário Da República n.º 30/2009, Série I de 2009-02-12| DRE*, n.d.), and the Personal Data Protection Law (*Lei n.º 58/2019 | DRE*, n.d.) it was noticed that:

- Art. 9 GDPR (Processing of special categories of personal data) says that:

"Processing of personal data revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and the processing of genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation shall be prohibited.", and continues saying that "Paragraph 1 shall not apply if one of the following applies: (…) (b) processing is necessary for the purposes of carrying out the obligations and exercising specific rights of the controller or of the data subject in the field of employment and social security and social protection law in so far as it is authorised by Union or Member State law or a collective agreement pursuant to Member State law providing for appropriate safeguards for the fundamental rights and the interests of the data subject;" (Radley-Gardner et al., 2016).

- Art. 29 GDPR (Processing under the authority of the controller or processor) says that:

"The processor and any person acting under the authority of the controller or of the processor, who has access to personal data, shall not process those data except on instructions from the controller, unless required to do so by Union or Member State law." (Radley-Gardner et al., 2016).

- Labour Code (*Lei n.º 7/2009 - Diário Da República n.º 30/2009, Série I de 2009-02-12| DRE*, n.d.):

Article 17.º (Protection of personal data) says that "1 - The employer cannot require a candidate or a worker to provide information on: a) Their private life, unless they are strictly necessary and relevant for assessing their suitability for the performance of the employment contract and the written

statement of the reasoning thereof;" (*Lei n.º 7/2009 - Diário Da República n.º 30/2009, Série I de 2009-02-12| DRE*, n.d.).

- Personal Data Protection Law (*Lei n.º 58/2019 | DRE*, n.d.):

Article 28.º (Labour relations) says that "1 - The employer may process the personal data of its workers for the purposes and with the limits defined in the Labour Code and respective complementary legislation or in other sectoral regimes, with the specificities established in this article." (*Lei n.º 58/2019 | DRE*, n.d.).

We can conclude that according to the Portuguese law in vigour and the new GDPR compliance guidelines, this approach is only possible and legal in case the candidate clearly approves and consents to allow this monitorization legally once that information is significant for evaluating him, depending on the position he is applying.

3.3.5. Ethical and deontological principles in the workplace that profile a Criminal Inspector

Under the Decree Law No. 138/2019 Article 6.º (*Decreto-Lei n.º 138/2019 | DRE*, n.d.), the *Polícia Judiciária* code of ethics promotes the values of justice, integrity, humanism, equality, honour, and dignity, conforming to the principles laid down in the "Constituição", in the "Carta dos Direitos Fundamentais da União Europeia", in the "Declaração Universal dos Direitos Humanos", in the "Convenção Europeia dos Direitos Humanos". These officials' books intend to establish measures that guarantee basic rights for a decent life, as well as in other international legal instruments that secure the Portuguese State.

In practice, these principles are all assessed in the psychological tests that last one hour and a half and in the interview that lasts thirty minutes. However, when the physical tests are carried out, the evaluators obtain a perception of the candidate's ethics, whether he is supportive or individualistic since those tests are done in group dynamics. Despite all these assessments, these may not prove to be sufficient to access the candidate's true values.

4. LITERATURE REVIEW

According to Hevner (*Design Science in Information Systems Research*, 2021), the foundations and methodologies constitute the knowledge base (Figure 1). Prior Information Systems research, as well as studies from related fields, will supply us with the knowledge needed.

With the advance of smarter cities, it is possible to develop collaborations, share data, and deliver real-time information on specific events due to the rapid distribution of linked mobile devices mediated by the network (Tundis et al., 2020). This evolution is also observed in Police agencies that resort to Information Technology and improve the intelligence systems via data collection in order to solve crimes, reduce the crime rate or even capture offenders (Tundis et al., 2020). Nonetheless, these entities will need to deliberate about how to handle such technology breakthroughs responsibly (Whitford et al., 2020).

In the USA Police Agencies, AI is already being applied to interrogators for deception detection to promote a non-biased environment (Noriega, 2020), and contributed to an automated fingerprint identification system (AFIS) used to find matches in a criminal laboratory, converting evidence into information (Whitford et al., 2020). In the first case, a research study compared the answer rate during AI-assisted national security screening interviews versus self-questionnaires of 120 United States Army basic trainees between 18 and 40 years old. The study used a computer-generated agent that mimicked human characteristics such as "types of verbal and nonverbal behaviors, human-like voice characteristics, facial features, and facial changes." Additionally, the computer-generated agent interviewed participants about their mental health, drug and alcohol use, and criminal records. For designing an artificial interrogator, three options are suitable. One option can be based on the expert design of decision tree reasoning (that simulates "the judgment and behavior of a human or an organization that has expert knowledge and experience in a particular field"); another option on predictive machine learning; or a combination of the two. This system demonstrates this ability through three parameters: 1) AI facial emotional recognition, the computer-generated algorithm detected changes in human emotion with a 90% accuracy rate versus a 75% accuracy rate for humans; 2) AI verbal emotion recognition, which suggested that changes in voice pitch are one common deception indicator that may indicate lying; 3) and Deception recognition software, which uses "multi-modal feature extraction" including motion, audio and transcript features, feature encoding, and facial micro-expression prediction. By drawing parallels between how detecting deception occurs in the courtroom and how it would occur in an interrogation room, the same strategy might be used in the interrogation room and potentially deliver identical results. It is essential to note the key technique of a human investigator who detects emotional changes can be executed by AI in real-time (Noriega, 2020).

In Europe, in collaboration with the Police Forces, in particular with Valencia Local Police (Spain), AI was crucial for developing a detection and tracking of criminals IoT (Internet of Things) system in smartphones' devices in order to predict their movements based on the user coordinates, report timestamp and crime type of a place in real-time (Tundis et al., 2020).

Turning now the attention to the social media thematic, where users have the will to express their feelings and opinions, those platforms nowadays are changing the human interactions (Boudlaie et al., 2019). They connect users from various parts of the world to collaborate with each other, to share

opinions, thoughts, and views. Social media are web-based services that permit users to create profiles, share links with others, and view the profiles and connections of other individuals (Boudlaie et al., 2019). The content is created or consumed at a specific time, location, site device, and application. Related to this, a study identified eight object types- "Comment; Event; Message; Post; Post-list; Profile; Profile-list; Relationship" and five basic actions on the social network – "View; Create; Update; Delete; Share". For instance, at that time, Facebook did not allow a message (object type) to be updated, deleted, or shared (actions), and neither did Twitter (Rosenberger et al., 2017).

Although users have the right to express their own opinions and interests on social media, employers have the power to use the information collected from potential employees on the Internet to examine and manage these job candidates (Boudlaie et al., 2019) to obtain more insights. This type of tracking is called Digital Footprint. Basically, the records and traces are left behind when using the Internet, which can be beneficial or harmful but are never pointless. It is expectable that when a user creates his profile page will include personal identifiers about himself, such as personal demographic information, as well as, other types of personal information, including political viewpoints and relationships status (Mergel, 2017). Afterwards, that information can affect their credibility. The digital footprint is considered an income-generating asset (Boudlaie et al., 2019), and because of that 70% of the surveyed recruitment managers say that they rejected job applicants because of an untrustworthy online reputation (Boudlaie et al., 2019). Hence, with the boost of information spread, the duty of showing a respectable online reputation on social media platforms increases, even more, when someone is about to be in charge of the Police authority. Besides this, opting for the use of a digital footprint in employment processes leads to the optimization of time, workforce, costs, and acquisition of visions, a better understanding of morals, manners, and thoughts (Boudlaie et al., 2019).

The Sentiment Analysis technique is employed when trying to analyze those platforms and their content and specifically the sentiment attached to the sentence that was exposed online. On one hand, the use of this technique is recent in Public Administration for contributing to the value creation, on the other, it is being used more regularly because of its ability to analyze large volumes of social media data, providing information related to citizen preferences, judgment, and feedback (Hand & Ching, 2020). It is usually used as a computer-supported, faster, scalable, and effective way of appraising social media users' sentiment, supported by most automated text classification tools (Dhaoui et al., 2017). This technique is used to classify any textual document into predefined categories displaying the polarity of sentiment in the text (Dhaoui et al., 2017). The sentiment polarity intends to distinguish any text into positive, negative, or neutral sentiment according to the polarity of the content (Dhaoui et al., 2017). It is a measure for assessing how users perceive something, for example, a public sector service, and that can be used to explore the opinion of social media users about that topic (Agostino & Arnaboldi, 2017).

AI is a technology that facilitates problem-solving, so it is efficient in finding solutions to a defined set of challenges. According to Marvin Minsky in 1961, "It can develop methods and conduct inductive reasoning to derive general principles learning from experience" (Marius et al., 2018). As it learns from experience, every time a keyword is recorded as questionable it will automatically be aware of it every time that word is used in a sentence from then on. For example, detecting online radicalization is possible following a two-steps approach: the first one applies a "Radicalization Score" composed of four elements: Average sentiment score percentile (AS), Volume of negative posts (VN), Severity of negative posts (SN), Duration of negative posts (DN); and a second step applying machine learning

techniques, SVM (support vector machine), K-NN (K-nearest neighbor), and random forest models. The keywords initially selected were "#islamophobia", "#bombing", "#terrorist", "#extremist", "radicalist" for the Twitter dataset, and #islamophobia, #islam is evil, #supremacy, #blacklivesmatter, #white racism, #jihad, #isis, and #white genocide, for the Tumblr dataset (Yin et al., 2018).

Based on four research papers it was possible to infer that Machine Learning techniques are preferred over Lexicon-based, although under different circumstances. In terms of detecting negative sentiment in sentences, the precision and f-score measures present a higher level, meaning that the effectiveness of the model as the proportion of true results in comparison with the total of cases is favorable. In the first research paper, the Bagging model was used to predict negative sentiment (Dhaoui et al., 2017); in the second, a framework proposed for email sentiment analysis combines K-means and SVM algorithm and achieved high accuracy (Hassani et al., 2020); afterwards, were applied Convolutional Neural Networks classifier (CNN with word to vector), and Recurrent Neural Networks classifier (with Long Short Term Memory and word to vector), once they provided the highest accuracy (Abd El-Jawad et al., 2018); and in the last one, SVM model was also used to analyze customer satisfaction through reviews text data (Lee et al., 2019).

Finally, in terms of AI principles, transparency, and explainability, among others, are needed, and the model should rely on them in order to improve human trust. When transparent models are preferred over black-box models, where the inputs and operations are not visible to the user, many benefits appear from it. For instance, a model composed of neural networks, SVM, or bagging, as the ones mentioned in the previous paragraph, is considered a black-box model which does not represent transparency since the behavior cannot be described. The AI system (the future employees who get accepted or who get rejected by the system) itself needs to grant a general understanding of the system. This allows the affected candidates by the system to inquire and challenge its outcomes (Wickramasinghe et al., 2020) because they have the possibility to ask for the reasons behind that decision. In the end, the methods implemented permit the users to comprehend the outcomes of the AI system clearly and easily (Wickramasinghe et al., 2020), so it tries to elucidate the doubts that may remain about the decisions that were made, which consequently makes the public more confident about the decision-makers (de Fine Licht & de Fine Licht, 2020). Transparency becomes a primary value, particularly to the Public Administration, whose mission is to implement the ethics policy founded at various levels of administration (Androniceanu, 2021).

4.1. SLR METHODOLOGY

The SLR analysis was performed by adopting a well-established systematic literature review and meta-analysis method, based on a checklist and flow diagram that both are part of the PRISMA Statement (Moher et al., 2009). Four main phases followed a defined structure: firstly, collecting the data, after it the announcement of the results and their analysis, then the discussion, and finally taking the legitimate conclusions.

1st phase: The PRISMA checklist (Moher et al., 2009) follows a structure with a title, abstract, introduction, methods, results, discussion, and other information (funding). For each section, there are specific items to be pointed out and characterized. The title and abstract follow an applicable structure. In the introduction, the rationale for the review and the objectives or questions to be addressed by the review should be described. In methods, eligibility criteria where the inclusion and exclusion

criteria are described, information sources, the search strategy, the statement process for studies selected, data collection, and data items are specified.

2nd phase: The results section provides screened results selection, through a flow diagram, characteristics of data extracted, and the synthesis of results. The flow diagram is composed of four main phases: identification, screening, eligibility, and inclusion of the main research papers. The main journals and conferences were identified and scrutinized considering that the analyse focus on ML or statistical approaches to be applied in social media, to discover the sentiment supporting job-seekers posts. In terms of keyword co-occurrence, authors' co-authorship, and title and abstract text occurrence, the results presented were possible using the bibliometric network software tool VOSviewer.

3rd phase: The discussion phase involves a summary of findings, meaning a general interpretation of the previous results in the context that follows the research questions and identifying the research gap.

4th phase: To conclude, an epitomize and the conclusion of the study are presented. According to such procedures, the publications that define the scope of the study were restricted to only journals and conferences published in the past five years, from 2017 to 2021, and the search was performed in September 2021.

4.2. DATA COLLECTION

4.2.1. PRISMA Method

With the adoption of the PRISMA guidelines (Moher et al., 2009), the SLR was performed as follows. First, a search process was performed to analyze publications that have in their titles, abstract or keywords the following Boolean expressions:

> ("social media" OR "track the digital footprint" OR "hate speech" OR "controversial online post*") AND ("artificial intelligence" OR "sentiment analysis" OR "machine learning" OR "lexicon-based" OR "AI technology") AND ("transparency" OR "artificial intelligence principle*") AND ("public institution*" OR "public contest*" OR "police force*" OR "public administration" OR "hiring strategy" OR "recruitment process")

The literature search was performed in September 2021 using the following three data repositories: Scopus, Science Direct, and Web of Science. Using 'OR', and 'AND' statements, all the papers published between the periods 1st January 2017 – 6th of September 2021 were included. The covered topics were multidisciplinary, including sociology, computer science, decision science, mathematics, and engineering.

The final set of SLR papers was structured using the Zotero reference manager open-source, cross-platform, and free tool (Murimboh & Hollingdale, 2012).

4.2.2. PRISMA Results

The following PRISMA flow diagram (Figure 9) illustrates the SLR data collection process.

The first step in this approach was to identify published papers through a database search resulting in 497 publications (Scopus: 471; Science Direct: 23; Web of Science: 3). It is also relevant to note that ten additional research papers were considered, due to their importance related to the topic for the development of the investigation. Afterwards, duplicates were verified and removed (e = 13) and all the papers without abstracts as well (e=5). The next step was performing title and abstracts screening. In the first phase, all the papers whose title was not relevant to the scope and objectives of this study were excluded (e = 345). In a second phase, were excluded all the papers whose abstract was not relevant to the scope and objectives of this study (e = 77).

Finally, in a third phase, all the papers according to the outlined inclusion and exclusion criteria were eliminated (e = 13). The inclusion criteria for such publications were original research papers written in English and published in Q1 or Q2 peer-reviewed journals and relevant conferences, between 2017 and 2021. Next, the full texts of the remaining 54 papers were read, appraised, and matched on the scope of the research. 20 papers were excluded given that they did not use ML, statistical techniques, or the theoretical framework was unsuitable for the main purpose of this work. In the end, the remaining 34 papers were considered eligible for further analysis in our systematic review. Of these, 27 papers were published in scientific journals and seven were published in conference proceedings.
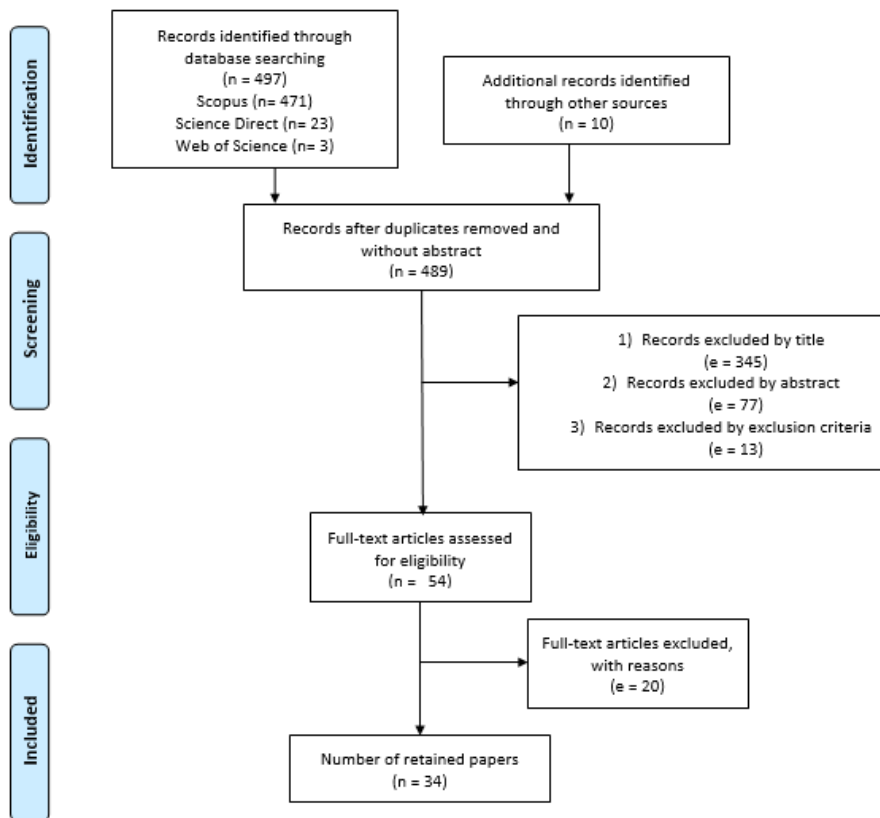
Figure 9 - PRISMA flow diagram (n = maintained; e = excluded)

4.3. RESULTS AND ANALYSIS

4.3.1. Main journals and conferences

In total, 34 literature papers were studied, and those 27 journal papers were analysed, including Government Information Quarterly (3), Public Administration Review (2), Transforming Government: People, Process and Policy (2), and all the other 18 journals only appear once. Table 2 shows that most journals are Q1-quartile ranked (13), representing approximately 50%; Q2-quartile-ranked (10); and one of the remaining three is not yet classified by the quartile-ranked (AD-minister) and the others: one is a book (Intelligent Data Engineering and Automated Learning – IDEAL 2018) and then another one a thesis report. The last journal is the only one that belongs to the Q3- quartile rank but was kept due to the fact that the research paper that was published there develops a conceptual framework divided into three phases about the AI decision-making and contributes to help in the investigation.

The four main publishers' fields identified in the analysis were computer science, social science, business management and accounting, and management of technology and innovation. The 27 selected articles' publishers come from five countries, with the most set from the United Kingdom (15) and Switzerland (3), followed by the Netherlands, United States of America, and Romania (2). The top publishers identified are Elsevier Ltd. (8), Emerald Group Publishing Ltd. (3), and Wiley-Blackwell (2); all the other publishers only appear once.

Table 2 – Main journals

Journals	Number	Quartile Rank	Publisher	Country	Field
Public Policy and Administration	1	Q2	SAGE Publications Ltd	United Kingdom	Social Sciences
Technological Forecasting and Social Change	1	Q1	Elsevier Inc.	United States	Management of Technology and Innovation
Administratie si Management Public	1	Q2	Academy of Economic Studies from Bucharest	Romania	Social Sciences
Government Information Quarterly	3	Q1	Elsevier Ltd.	United Kingdom	Social Sciences
AD-minister	1	-	-	-	-
Journal of Consumer Marketing	1	Q2	Emerald Group Publishing Ltd.	United Kingdom	Business management and accounting
Public Organization Review	1	Q2	Kluwer Academic Publishers	Netherlands	Business, Management, and accountant
Big Data and Cognitive Computing	1	Q2	MDPI AG	Switzerland	Computer science
Annals of "Dunarea de Jos" University of Galati Fascicle I. Economics and Applied Informatics	1	Q2	Transilvanian Association for the Literarure and Culture of Romanian People (ASTRA)	Romania	Social Sciences
Public Administration Review	2	Q1	Wiley-Blackwell	United Kingdom	Social Sciences
Advanced Engineering Informatics	1	Q1	Elsevier Ltd.	United Kingdom	Computer Science
Futures	1	Q1	Elsevier Ltd.	United Kingdom	Social Sciences
Information Systems Frontiers	1	Q1	Springer Netherlands	Netherlands	Computer Science
Technology in Society	1	Q1	Elsevier Ltd.	United Kingdom	Social Sciences
Sensors	1	Q2	MDPI Multidisciplinary	Switzerland	Computer Science

			Digital Publishing Institute		
Transforming Government: People, Process and Policy	2	Q2	Emerald Group Publishing Ltd.	United Kingdom	Computer Science
International Journal of Information Management	1	Q1	Elsevier Ltd.	United Kingdom	Computer Science
Computers in Human Behavior	1	Q1	Elsevier Ltd.	United Kingdom	Computer Science
International Journal of Public Administration	1	Q2	Taylor and Francis Ltd.	United States	Social Sciences
ISPRS International Journal of Geo-Information	1	Q1	MDPI AG	Switzerland	Social Science
AI & Society	1	Q3	Springer London	United Kingdom	Computer Science

In total, seven conference papers were analysed from the 34 studies. The essential conferences identified in this study were ACM International Conference Proceeding Series; Proceedings of the Annual Hawaii International Conference on System Sciences; Proceedings - 20th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing, SNPD 2019; International Conference on Human System Interaction, HIS; and ICENCO 2018 - 14th International Computer Engineering Conference: Secure Smart Societies. Table 3 shows that the main research areas of the conferences are computer science and engineering from the United States.

Table 3 – Main conferences

Conference	Number	Publisher Country	Field
ACM International Conference Proceeding Series	3	United Sates	Computer Science
Proceedings of the Annual Hawaii International Conference on System Sciences	1	United States	Engineering
Proceedings - 20th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing, SNPD 2019	1	United States	Computer Science
International Conference on Human System Interaction, HIS	1	United States	Computer Science
ICENCO 2018 - 14th International Computer Engineering Conference: Secure Smart Societies	1	United Sates	Computer Science

4.3.2. Keyword Co-occurrence Analysis

The keyword co-occurrence analysis performed used the mentioned bibliometric research tool for network analysis, VOSviewer. The analysis used a full counting method, encompassing 120 screened keywords, with one occurrence as the minimum threshold. Only 30 keywords from the total 120 were selected for the analysis (Table 4). Most of the analysed keywords were related to machine learning techniques and sentiment analysis applied to social networking. The top five identified terms were social networking (online) (3 occurrences, 29 total link strength), decision making (2 occurrences, 20 total link strength), e-government (2 occurrences, 20 total link strength), machine learning (2

occurrences, 20 total link strength) and sentiment analysis (2 occurrences, 20 total link strength), aligned with the keyword search as expected.

Table 4 – Keyword co-occurrences ranked by total link strength

Keyword	Occurrences	Total Link Strength
Social networking (online)	3	29
Decision making	2	20
E-government	2	20
Machine learning	2	20
Sentiment analysis	2	20
Behavioral research	1	17
Classification (of information)	1	17
Content analysis	1	17
Decision makers	1	17
Decision making process	1	17
E-participation	1	17
Electronic data interchange	1	17
Electronic participation	1	17
Learning algorithms	1	17
Public participation	1	17
Public policy	1	17
Social media platforms	1	17
Unsupervised machine learning	1	17
Public administration	2	12
Government services	1	9
Integration	1	9
Integration software	1	9
Network applications	1	9
Open datum	1	9
Social media tools	1	9
Social sciences computing	1	9
User activity	1	9
Public services	2	4
Internet of things	2	3
Artificial intelligence	6	1

In keyword co-occurrence analysis, the result was three clusters with 30 items and 204 links. The popular nodes of each cluster in the network were identified as machine learning, sentiment analysis, e-government, and decision-making (red cluster); social networking (online) (green cluster); and artificial intelligence (blue cluster).
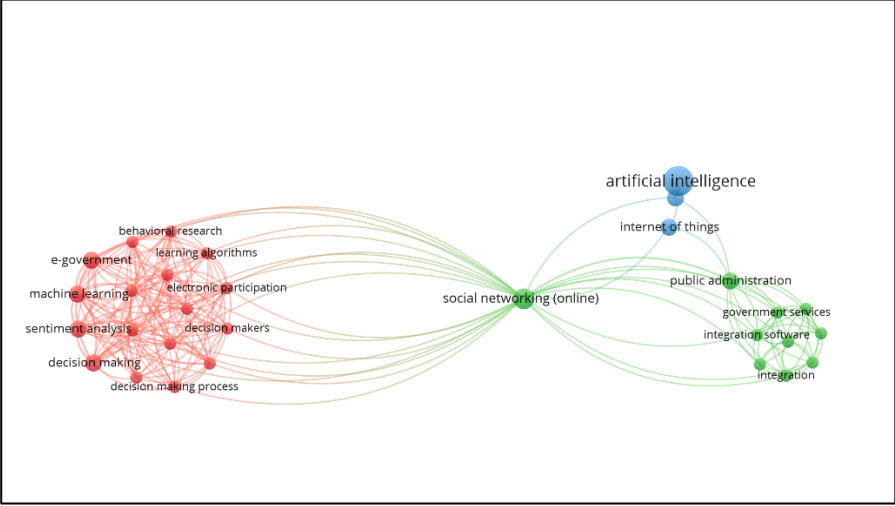
Figure 10 - Keyword co-occurrence network visualization

The connections among the research themes identified by keyword co-occurrence are demonstrated in Figures 10 and 11. There is a large group of keywords that occur together in individual articles, mostly in 2020.
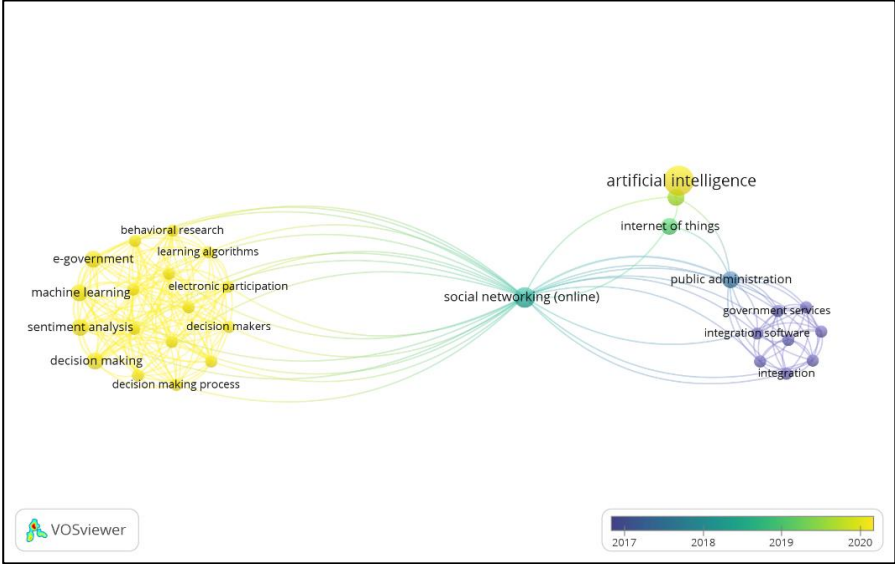
Figure 11 - Keyword occurrence by year overlay visualization

The keyword analysis showed research fields reinforcing the topics of AI, public administration and identified sentiment analysis techniques applied to social networks. When inspecting the density visualization (Figure 12), the artificial intelligence keyword outstands in comparison to the other keywords.
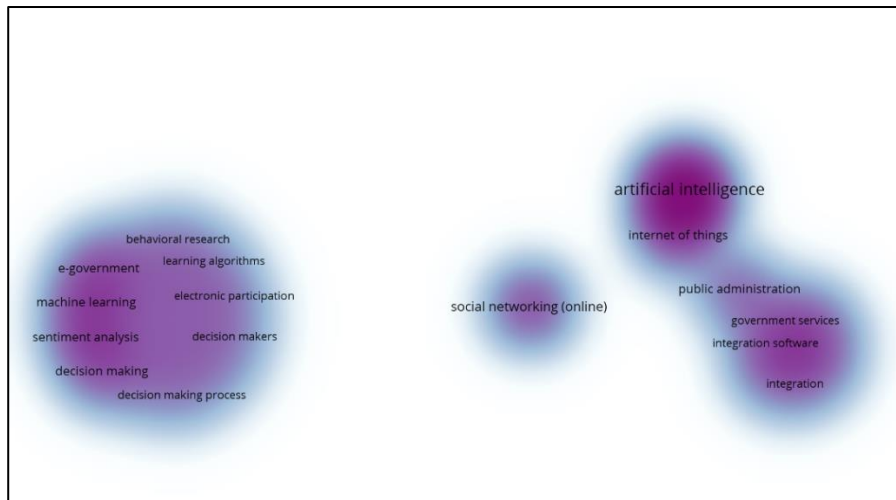
Figure 12 - Keyword co-occurrence density visualization

4.3.3. Author Co-authorship Analysis

Author co-authorship analysis was performed with the previously mentioned bibliometric research tool for network analysis, VOSviewer. The analysis on co-authorship was performed using a full counting method, choosing one as the minimum threshold, resulting in a total of 94 authors meeting the threshold, and from those 35 authors were analyzed.

The top 10 identified authors were Anastasopoulos, j.l.; Anderson, d.m.; Burchfield, a.; Whitford, a.b.; Yates, j.; Beneki, c.; Hassani, h.; Mazinani, m.t.; Unger, s.; Yeganegi, m.r., all presenting a total link strength of four. In Table 5, the Total Link Strength attribute represents the total strength of the co-authorship ties of a given researcher with other researchers (van Eck & Waltman, n.d.).

Table 5 – Author co-authorship ranked by total link strength

Author	Documents	Total Link Strength
Anastasopoulos, j.l.	1	4
Anderson, d.m.	1	4
Burchfield, a.	1	4
Whitford, a.b.	1	4
Yates, j.	1	4
Beneki, c.	1	4
Hassani, h.	1	4
Mazinani, m.t.	1	4
Unger, s.	1	4
Yeganegi, m.r.	1	4

Chen, chun-hsien	1	4
Jiao, jianxin (roger)	1	4
Lee, c. k. m.	1	4
Ng, kam k. h.	1	4
Yang, zhi-xin	1	4
Dhir, Amandeep	1	4
Islam, jamid ul	1	4
Kaur, puneet	1	4
Ruparel, namita	1	4
Tandon, anushree	1	4
Cho, y.w.	1	3
Gim, g.-y.	1	3
Im, e.t.	1	3
Lee, s.h.	1	3
Grandio, javier	1	3
Manic, milos	1	3
Marino, daniel l.	1	3
Wickramasinghe, chathurika s.	1	3
Beverungen, daniel	1	2
Hofmann, sara	1	2
Raeckers, michael	1	2
Krcmar, h.	1	2
Laurim, v.	1	2
Prommegger, b.	1	2
Marius, geru	1	0

In the author's co-authorship analysis, nine clusters were established with 35 items and 58 links. Cluster 1 (red) corresponds to the top five author co-authorship ranked by link strength (Table 5); Cluster 2 (green), Cluster 3 (blue), and Cluster 4 (yellow) have five items identified; Cluster 5 (purple) and Cluster 6 (cyan) have four items identified; Cluster 7 (orange) and Cluster 8 (brown) have three items; and Cluster 9 (pink) only one item (Figure 13).
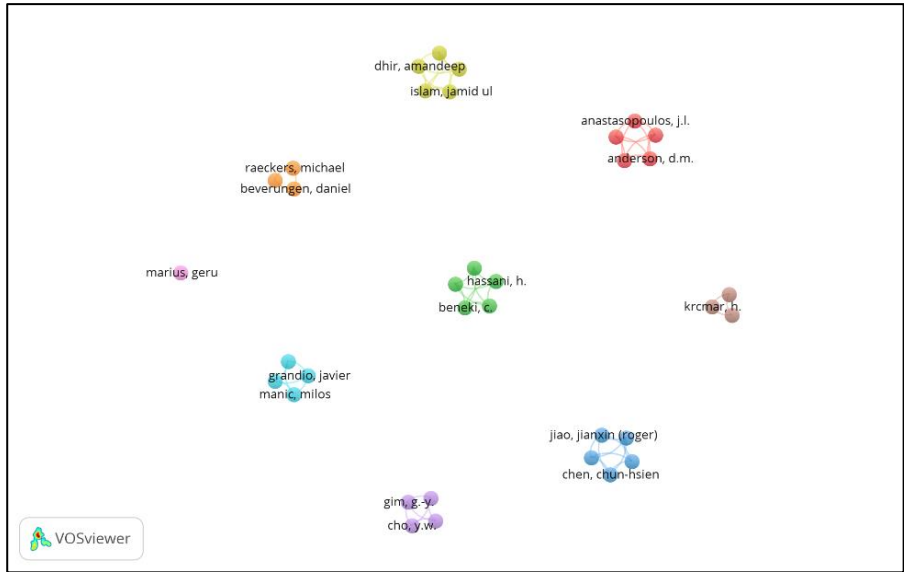
Figure 13 - Author co-authorship analysis network visualization

Cluster 7 and Cluster 9 correspond to authors who published articles in 2018; Cluster 5 corresponds to authors with publications in 2019; Cluster 1, Cluster 2, Cluster 4, and Cluster 6 correspond to authors with publications in 2020; for the remaining authors, articles were published in 2021 (Figure 14). Figure 14 shows that the top 10 author co-authorship, belonging to Cluster 1 and 2, were published in 2020.
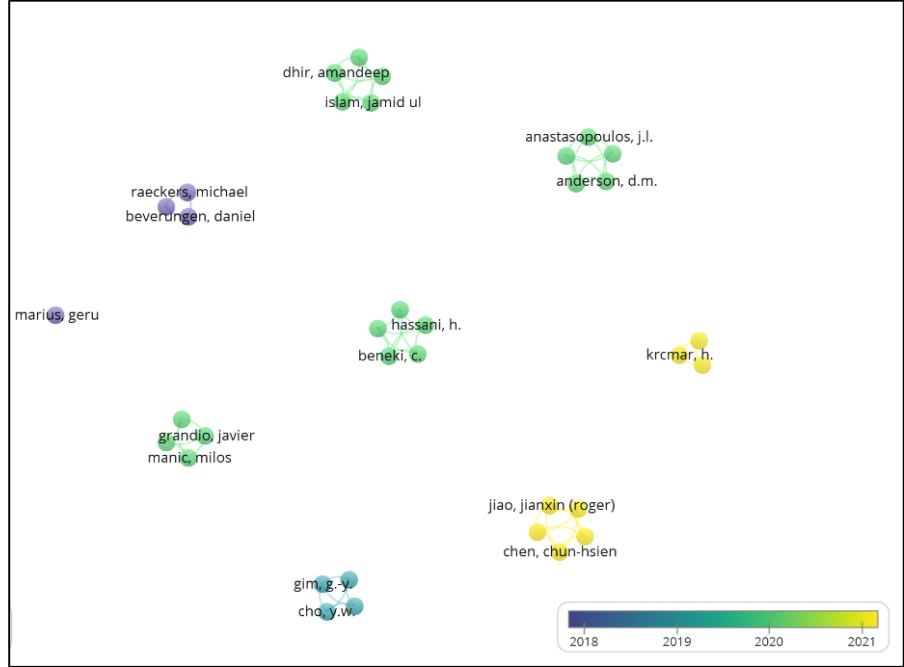
Figure 14 - Author co-authorship analysis by year overlay visualization

4.3.4. Title and Abstract Text Occurrence Analysis

Title and Abstract analysis were achieved with the VOSviewer tool, as well. The text data analysed used a full counting method and included 986 screened items with a minimum threshold of three occurrences, resulting in 112 items that meet the threshold. The relevance score was calculated for 60% of the sample as a standard reference for the calculation, and based on this score 67 terms were selected due to their relevance. Terms with a high relevance value indicate specific themes covered by the text data, whereas terms with a low relevance score are more general in nature (van Eck & Waltman, n.d.). Table 6 presents the 11 most relevant terms encountered and are announced by descending relevance order.

Table 6 – Title and abstract text occurrences ranked by relevance

Term	Occurrences	Relevance
cooperation	3	2.88
false confession	3	2.88
human bias	3	1.79
implementation	3	1.77
ministry	6	1.65
customer	3	1.60
user activity	4	1.56
public institution	7	1.42
rpa	4	1.38
intention	3	1.31
job seeker	3	1.31

The analysis computed a network with 67 items, eight clusters, 343 links, and a total link strength of 1721 (Figure 15). The network highlighted an eight-cluster network, being the most significant nodes of each identified as sentiment analysis (Cluster 1- red); trust (Cluster 2- green); role (Cluster 3- blue); technology (Cluster 4- yellow); public institution and social networking (Cluster 5- purple); local government (Cluster 6- cyan); value creation (Cluster 7- orange); and cooperation (Cluster 8- brown).
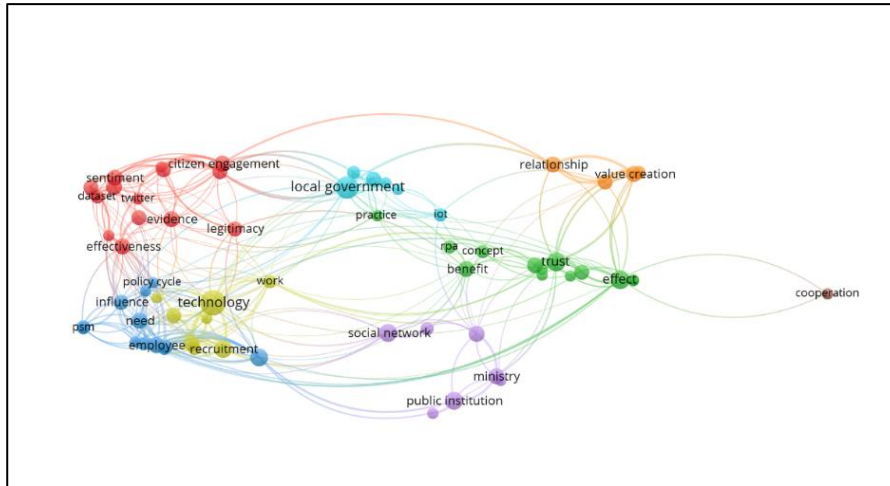
Figure 15 - Title and abstract text occurrence network visualization

Figure 16 shows that sentiment analysis, achieved through machine learning techniques, is applied to the local government and the public institutions within the analysis of the social networks in most of the articles published since 2018.
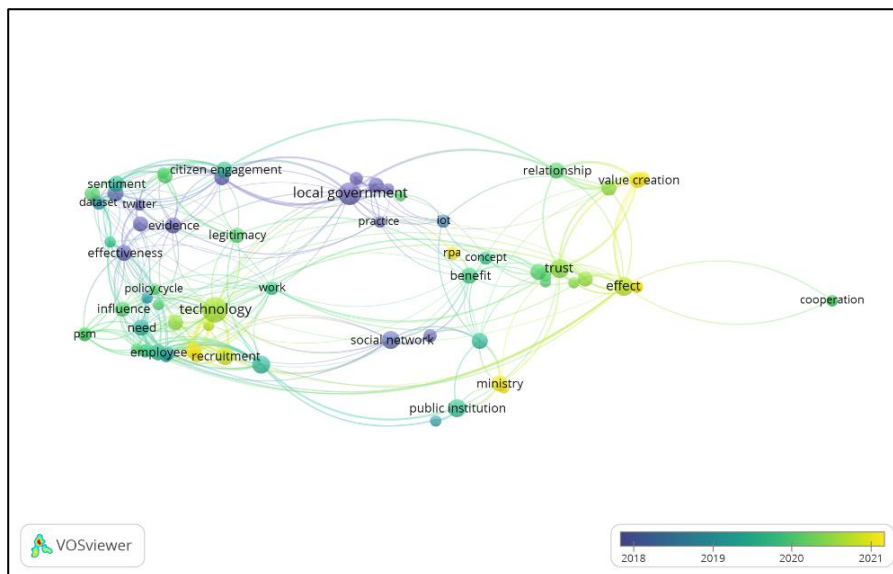
Figure 16 - Title and abstract text occurrence by year overlay visualization

4.3.5. Most cited publications

Examining the most cited publications facilitated the knowledge discovery and the detection of the most important research topics in the literature. A search for the most cited publications was conducted using Scopus, Science Direct, and Web of Science databases, and the articles displayed have been cited between 130 times and 0 times. The following table (Table 7) exhibits this process resulting in a theoretical framework with each paper dimensions, methods and tools used, and research gaps found.

Table 7 – Publications ranked by the number of citations

N.	Article Title	Publication (Journal/ Conference Proceeding)	Method/ Tools	Research Gaps	N. of Citations
1	What makes local governments' online communications successful? Insights from a multi-method analysis of Facebook	Government Information Quarterly	- Sentiment analysis provided by the software tool AlchemyAPI - Statistical analysis	Deeper insight into the topics of successful and unsuccessful communications on SNSs (social networking sites)	130
2	Social media sentiment analysis: lexicon versus machine learning	Journal of Consumer Marketing	- Lexicon based approach (LIWC2015- TM software) - Machine Learning approach (RTextTools- R package; MaxEnt- predict positive sentiment, and Bagging- predict negative sentiment)	Appraise if a combined approach improves the overall accuracy of the sentiment classification of social media conversations (Facebook)	89
3	Twitter as a tool for citizen engagement: An empirical study of the Andalusian municipalities	Government Information Quarterly	- Twint (python library) - R software ("TM"- text mining and "dplyr" libraries) - Statistical analysis	Check if exists a significant relationship between content type and citizen engagement	61
4	Sentiment Analysis of Social Media Networks Using Machine Learning	ICENCO 2018 - 14th International Computer Engineering Conference: Secure Smart Societies	- Decision Tree - Naive Bayes - Random Forest - Neural Network with 10 hidden multilayer perceptron - Recurrent Neural Networks with (LSTM) - Convolutional Neural Networks algorithms	Compare the performance of different machine learning and deep learning algorithms, in addition to introducing a new hybrid system that uses text mining and neural networks for sentiment classification (Twitter)	35
5	Artificial intelligence, transparency, and public decision-making: Why explanations are key when trying to produce perceived legitimacy	AI & SOCIETY	- Conceptual framework developed about the three phases of AI decision-making	Discuss how transparency in AI decision-making can affect the public's perception of the legitimacy of decisions and decision-makers	28
6	Building Holistic Evidence for Social Media Impact	Public Administration Review	- Comprehensive approach	Perceive how public administration researchers and practitioners are using social media data that they can easily collect from social media platforms and contrast these practices with data measurement efforts that can provide deeper insights for evidence-based decision making	22
7	Text mining in big data analytics	Big Data and Cognitive Computing	- Text Representation (Bag of Words, Bag of Characters, Bag of Features, n-gram, Relational Graph) - Similarity Measures (String-based, Corpus-based, Knowledge-based) - Dimension Reduction (SVD, Latent Semantic	Determine the state of text mining research by examining the developments within published literature over past years and providing valuable insights for practitioners and researchers on the predominant trends, methods, and applications of text mining research	20

		Analysis (LSA), Probabilistic LSA, Isomap, Multidimensional Scaling) - Classification and Clustering (Naive Bayes, K-means, SVM, Artificial Neural Network) - Logistic Regression		
8	Integrating data from user activities of social networks into public administrations	Information Systems Frontiers	- Design Science Approach to develop a data model of user activity in social networks	Drive innovation in governments through the integration of user activities from social networks into government applications	17
9	Social media data used in the measurement of public services effectiveness: Empirical evidence from Twitter in higher education institutions	Public Policy and Administration	- R software - Cluto (build clusters) - TreeTagger (sentiment analysis)	Examine how well public bodies use social media, providing several specific measures for the purpose	13
10	The Dark Sides of Artificial Intelligence: An Integrated AI Governance Framework for Public Administration	International Journal of Public Administration	- AI Governance framework	Describe key aspects of AI governance and a guide for the regulatory process of AI and its application	12
11	The influence of online professional social media in human resource management: A systematic literature review	Technology in Society	- Technology acceptance model (TAM) - Information systems (IS) continuance model	Identify specific features that draw users to PSMs (Professional social media) concerning job boards	11
12	A systematic literature review on intelligent automation: Aligning concepts from theory, practice, and future perspectives	Advanced Engineering Informatics	- Text mining analytics - NLP (natural language processing) - Voice recognition - Tools for understanding customers' expectations, comments, and queries and improve customer service interactions	Address the key contributions of the selected literature, IA's (intelligent automation), benefits, implementation considerations, challenges, and potential IA applications to foster the relevant research development in the domain	9
13	Transparency in public administration as a challenge for a good democratic governance	Administratie si Management Public	- Questionnaire - Excel - SPSS	Evaluate how ministries have made progress in ensuring administrative transparency	6
14	Digital footprint in Web 3.0: Social Media Usage in Recruitment	AD-minister	- Ten in depth Interviews	Discover key issues in the use of digital footprint in recruitment	5
15	Maintaining neutrality: A sentiment analysis of police agency Facebook pages before and after a fatal officer-involved shooting of a citizen	Government Information Quarterly	- JavaScript programming language to query Facebook's Graph Application Programming Interface (API) (data collection) - Google Cloud's Natural Language API (sentiment analysis) - Statistical analysis	Evaluate if Police Agencies primarily use social media as a way to manage their public image rather than for citizen engagement	5
16	Using Artificial Intelligence on Social Media's User Generated Content for	Annals of "Dunarea de Jos" University of	- Google cloud vision - K-means (clustering)	Learn how user-generated content on social media (Instagram) can act as a	5

		Disruptive Marketing Strategies in eCommerce	Galati Fascicle I. Economics and Applied Informatics		marketing research instrument in identifying consumer behavior	
17	The application of artificial intelligence in police interrogations: An analysis addressing the proposed effect AI has on racial and gender bias, cooperation, and false confessions	Futures	- Artificial intelligence (Human-Robot Interaction)	Investigate the potentiality of AI as an interrogator within a Police interrogation to promote a non-biased environment	3
18	The Adoption of Robotics by Government Agencies: Evidence from Crime Labs	Public Administration Review	- Statistical analysis - Census of crime labs	Compare the adoption and use of robotics as a key emerging leading-edge technology as advanced economies undergo the latest technological revolution in U.S. crime laboratories	3
19	Trustworthy AI Development Guidelines for Human System Interaction	International Conference on Human System Interaction, HSI	- Theoretical framework with concepts of trustworthy AI - AISLC (Artificial intelligence System Life Cycle)	Define the guidelines and frameworks for improving user trust in AI systems, allowing humans to use them without fear	3
20	Intelligent recruitment: How to identify, select, and retain talents from around the world using artificial intelligence	Technological Forecasting and Social Change	Five experiments with participant observation, and qualitative data collection: - LinkedIn - Mooc - Game - Chatbot from textrecruit - System randstad.tech	Explore the emerging phenomenon of e-recruitment and the extent to which it can improve the identification, selection, and retention of talents to enable social businesses to achieve their goals	2
21	Co-producing public value through IoT and social media	ACM International Conference Proceeding Series	- Interview sessions at seven different government agencies - LoRa - Low Power Wide Area Network - Networks (collecting data in sensors)	Test if using crowdsourcing or SMM (social media monitoring) is possible to achieve co-production in the public sector	2
22	Computer, whom should I hire? - Acceptance criteria for artificial intelligence in the recruitment process	Proceedings of the Annual Hawaii International Conference on System Sciences	- 15 Semi-structured interviews as a survey method (recruiters, managers, and applicants) - Technology Acceptance Model (TAM)	Identify acceptance criteria concerning AI-based technology in the recruitment process	2
23	Detecting and tracking criminals in the real world through an IoT-based system	Sensors	- IoT system - GUI - Javascript - NeoJS	Contemplate the IoT social devices for supporting the detection and tracking of criminals in the real world	2
24	The use of public sector data analytics in the Netherlands	Transforming Government: People, Process and Policy	- Web search - Consultation with policymakers	Explore the use of public sector data analytics in the Netherlands and the opportunities and challenges of this use	2
25	How Mayors Perceive the Influence of Social Media on the Policy Cycle	Public Organization Review	- Survey - K-means model (clustering) - Logistic regression	Discover potential influences of social media on the policy cycle stages and perceive if the influence of social media	1

				change depending on certain characteristics of mayors	
26	A Study on Customer Satisfaction Analysis of Public Institutions using Social Textmining	Proceedings - 20th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing, SNPD 2019	- KoNLP Library (R program to conduct a morpheme analysis) Sentiment dictionary: - AFINN - Opinion Lexicon - EmoLex - SentiWordNet - SVM	Suggest a new method for analyzing customer satisfaction through social text mining	1
27	What is the impact of Information Systems on democracy promotion and the role in decision-making process	NOVA UNIVERSITY Repository: Thesis report	- Conceptual framework to improve the democratic processes developed under DSR (design science research) - Nine semi-structured interviews to experts	Contribute to a better understanding of modern democracy and how democracy can be shaped by information systems solutions	1
28	Social media enabled e-Participation: A lexicon-based sentiment analysis using unsupervised machine learning	ACM International Conference Proceeding Series	- Nvivo's NCapture (web scraping tool for sampling a qualitative data analysis) - Orange 3.22.0, an open-source AI-based platform to do unsupervised ML technique (preprocessing) - Sentiment analysis (lexicon-based technique called VADER) - Clustering (hierarchical clustering algorithm) - Content analysis	Understand the feelings and opinions about a social phenomenon using social media channels (Facebook) for e-participation	0
29	Human biases in government algorithms	ACM International Conference Proceeding Series	- TextBlob (Open source sentiment analysis python libraries) - VADER (a knowledge-based solution) - Microsoft Azure's proprietary Text Analytics API (operating from the end user's perspective as a black box)	Evaluate through sentiment analysis algorithms if they show human bias by interchanging lists of names associated with gender, race, and political orientation	0
30	Public and private value creation using artificial intelligence: An empirical study of AI voice robot users in Chinese public sector	International Journal of Information Management	- Research model: examine the relationship between citizen AI voice robot usage and value creation in the public sector. - Statistical analysis	Analyse the relationship between AI use and value creation from the citizen perspective	0
31	Repelled at first sight? Expectations and intentions of job-seekers reading about AI selection in job advertisements	Computers in Human Behavior	- Interviews (three studies with job-seekers under different situations) - Statistical analysis	Inspect the effect of the prospect of automated procedures on job-seekers' pre-process perceptions and intentions	0
32	Machine Learning Approaches to Bike-Sharing Systems: A Systematic Literature Review	ISPRS International Journal of Geo-Information	Machine learning techniques: - Clustering: Hierarchical clustering - Predicting: Random Forest	Selection of Machine Learning techniques that are best fitted and have better performance to solve BSSs at a multilevel scope	0
33	Which technology to which challenge in democratic	Transforming Government:	- Conceptual framework developed under DSR (design science research)	Analyse the potential adequacy of different IS instruments to deal with	0

	governance? An approach using design science research	People, Process and Policy	- Structured interviews with nine experts	democratic governance challenges, establishing functional relationships between specific goals and potentially compatible technologies	
34	On Detecting Online Radicalization Using Natural Language Processing	Book: Intelligent Data Engineering and Automated Learning – IDEAL 2018	- Radicalization Score (Java-based software SentiStrength) - Machine Learning strategy (SVM, K-NN, Random Forest, n-gram, WordNet Affect, LWIC)	Establish an innovative approach for radicalization detection using Natural Language Processing techniques on Twitter and Tumblr	/

The top five identified publications are from the following authors: Hofmann, S., Beverungen, D., et al. (Hofmann et al., 2013) with 130 citations (the most cited); followed by Dhaoui, C., Webster, C. M., & Tan, L. P (Dhaoui et al., 2017) with 89 citations; Bonsón, E., Perea, D., Bednárová, M. (Bonsón et al., 2019) with 61 citations; Abd El-Jawad, M. H., Hodhod, R., & Omar, Y. M. K. (Abd El-Jawad et al., 2018) with 35 citations; and de Fine Licht, K., & de Fine Licht, J. (de Fine Licht & de Fine Licht, 2020) with 28 citations. These papers are not only the most cited as they also present the main concepts in the field.

Additionally, from the top five cited papers identified in Table 7, two were published in a Q1- ranked journal (Government Information Quarterly), one in a Q2-ranked journal, one in a Q3-ranked journal, and one is a conference paper. Relatively to the keyword co-occurrence analysis, the term artificial intelligence in pair with machine learning and sentiment analysis was notable, and that is because the most cited publications adopted those techniques.

Moreover, several machine learning and statistical methods were employed for sentiment analysis on the SLR papers read. The 10 topmost cited papers combined different methods, namely numerous machine learning techniques to perform sentiment analysis, some of them relying on software or APIs (Application Programming Interface) and statistical analysis. The majority of algorithms used were decision trees, SVM, artificial neural networks, and random forest, among others (Table 7). Few studies preferred Lexicon-based methods over machine learning, only two studies (Pitogo & Ramos, 2020; Thurnay & Lampoltshammer, 2020). As case studies, social media studies utilized Facebook (Dhaoui et al., 2017; Hand & Ching, 2020; Hofmann et al., 2013; Pitogo & Ramos, 2020), Twitter (Abd El-Jawad et al., 2018; Agostino & Arnaboldi, 2017; Bonsón et al., 2019; Yin et al., 2018), Instagram (Marius et al., 2018), and Tumblr (Yin et al., 2018) for collecting and interpreting their data. Other case studies used Government or Public Administration data (Agostino & Arnaboldi, 2017; Androniceanu, 2021; Hedestig et al., 2018; Lee et al., 2019; van Veenstra et al., 2020; Wang et al., 2021) or developed a theoretical approach around it (Mergel, 2017; Rosenberger et al., 2017; Wirtz et al., 2020); three studies utilized Police data (Noriega, 2020; Tundis et al., 2020; Whitford et al., 2020); transparency concepts applied to AI and Public Administration (Androniceanu, 2021; de Fine Licht & de Fine Licht, 2020; Wickramasinghe et al., 2020); and recruitment strategies that rely on new technologies or AI (Allal-Chérif et al., 2021; Boudlaie et al., 2019; Laurim et al., 2021; Wesche & Sonderegger, 2021). Additionally, six research papers resorted to interviews (Anastasiadou, 2019; Anastasiadou et al., 2021; Boudlaie et al., 2019; Hedestig et al., 2018; Laurim et al., 2021; Wesche & Sonderegger, 2021), five research papers applied two distinct clustering algorithms, K-means (Giacomini & Simonetto, 2020; Hassani et al., 2020; Marius et al., 2018), or hierarchical clustering (Albuquerque et al., 2021; Pitogo & Ramos, 2020), and three research papers developed a SLR addressing the main topic (Albuquerque et

al., 2021; Ng et al., 2021; Ruparel et al., 2020). A research paper utilized the hierarchical clustering algorithm in order to obtain the content analysis (Pitogo & Ramos, 2020). Content analysis is defined as a research method that investigates a wide spectrum of problems by systematically and accurately identifying the particular characteristics of messages (Bonsón et al., 2019).

4.4. DISCUSSION SLR

This sub-chapter intends to highlight and identify the main literature about AI technologies and statistical techniques that undertake the problems identified and related to the recruitment process of future Police candidates, and consequently creates a conceptual framework (artefact) employing the systematic review of the literature studies.

Following is the discussion of how the study answers the proposed research questions, which are restated below:

- RQ1: "What are the most important facts facing Public Institutions regarding the usage of AI technologies to make decisions about evaluating and selecting candidates?"
- RQ2: "How can the usage and exploitation of transparent AI have a positive impact on the recruitment process of a Public Institution?".

4.4.1. Research questions discussion

To answer the first research question was necessary to understand the existing gaps in the selection criteria of the Public Contests that are in vigor, specifically in Police Forces. The gaps pointed out in the interview by the President of the Jury of *Polícia Judiciária* were fully described in the third chapter (3.3.1. Identify the gaps associated with those phases). Besides this, it is relevant to understand statistically who the candidates are, meaning that a profiling based on sociodemographic characteristics of the future Criminal Inspectors according to the provided dataset will be elaborated (age, gender, nationality, education level, study area, and place of living). This follows the same approach that another study made through a survey, where sociodemographic variables were assessed in order to understand and learn more about the participants (Wesche & Sonderegger, 2021). This segmentation results from the application of unsupervised models like K-means (Marius et al., 2018) or hierarchical clustering (Pitogo & Ramos, 2020) algorithms which produce clusters.

Regarding the second research question, the SLR analysis shows that the two main problems addressed by the sentiment analysis techniques are machine learning and lexicon-based applied to social media networks.

The reviewed papers allowed us to conclude that machine learning techniques are preferred when predicting the polarity, namely the negative polarity assigned to a sentence (Dhaoui et al., 2017). A study demonstrated how the polarity of a text was assessed by comparing the words in the text with a word list that assigns a positive or negative weight to each word. In recent approaches, machine-learning techniques include and improve the word lists, assessing the contextual meaning of words, and interpreting texts on the document and sentence levels simultaneously (Hofmann et al., 2013).

Two papers opted for implementing decision trees and naive bayes (Abd El-Jawad et al., 2018; Hassani et al., 2020), while others used black-box models like artificial neural networks, SVM, random forests, KNN (K-nearest neighbor), or bagging (Abd El-Jawad et al., 2018; Dhaoui et al., 2017; Hassani et al., 2020; Lee et al., 2019; Yin et al., 2018). However, the framework to be developed should not rely on these black-box models once their operations and behavior are not possible to describe. This framework aims to be transparent, free of bias and will help the recruiter to deduce new insights about a candidate while suggesting new complements to evaluate the candidate's behavior and speech in

their professional interview and respective social media. A study demonstrated that when applying sentiment analysis technique, biases do not show based on names alone. Nonetheless, it does not mean that this solution at hand produces results that are free of gender-based, racial, or political (Thurnay & Lampoltshammer, 2020).

Concerning facial expression emotional recognition, the literature affirms that is one of the most crucial ways of interpersonal communication (Song, 2021). People's faces reflect a range of expression patterns when they are experiencing basic emotions. CNNs model can be a helpful tool for that recognition and in the employment of candidates while being evaluated in an AI-assisted interview.

As mentioned before many recruiters opt for checking the candidate's social media before recruiting him (Allal-Chérif et al., 2021), which indicates that this automated and evidence-based solution should be well received by them. Furthermore, choosing candidates that present ethical, political, social, and other values aligned with the values and vision of the Institution will lead to the optimization of time and costs, as well as the acquisition of new perspectives, a better understanding of morals, manners, and thoughts (Boudlaie et al., 2019).

4.4.2. Conceptual solutions

The AI capabilities are fundamental, and they can solve the problems in the evaluation and selection phases of Public Contests while designing programs that can help and act immediately. The solutions proposed that result from a well-established SLR are divided into lexicon-based and machine learning techniques. It will ensure and deal with the lack of trustworthiness of future Criminal Inspectors while helping in knowledge discovery. Below some AI techniques are introduced and characterized:

- **Lexicon-based**

The lexicon-based approach is one possibility to perform the sentiment analysis and generally relies on a dictionary of opinion words, also known as a sentiment dictionary or a sentiment lexicon. It identifies and determines the sentiment orientation as positive or negative. It requires time and effort once the compilation of a sentiment lexicon needs to be done manually. A research paper tested this approach in conversational social media data consisting of 850 Facebook user comments about 83 luxury fashion brand pages. The LIWC2015 (Linguistic Inquiry and Word Count) was used, a text mining tool, which examines the most prevalent words included in its dictionaries (Dhaoui et al., 2017).

- **Artificial neural network (ANN)**

This is the first machine learning technique option that belongs to a black-box model. In this model, each layer's input is the previous layer's output. It takes the input features and combines them with weights and biases to predict output value. Among other techniques, this one was applied with 10 layers to analyze more than 1 million tweets collected from GitHub, Kaggle repository, and Twitter 140 API in order to predict the direction of the sentiment presented on them (Abd El-Jawad et al., 2018) (Lin, 2019). Convolutional neural networks (CNN) is a class of ANN and one of the most widely used machine learning algorithms for image classification effect since it is outstanding. As a result, many researchers have begun to use neural networks to solve the challenge of facial emotion recognition. A

research paper opted for machine learning theory and emotional philosophy for developing a fusion dual-channel expression recognition system (Song, 2021).

- **Support vector machine (SVM)**

Supervised learning algorithms are selected when there is a set of predictors to predict the dependent variable. The algorithm applies the target observed values to train a prediction model. SVM is a set of supervised learning methods used for classification and prediction. It exploits the structural risk minimization principle of computational learning theory, explores a decision surface to categorize the training data points into two classes, and makes decisions based on the SVM. This model separates the classes by building a margin to minimize the distance between each class and that margin. An example of use has been predicting someone's opinion or their system of beliefs and ideology based on their speech or written messages (Hassani et al., 2020).

- **Bagging**

In the bagging classification approach, each tree is built from a bootstrap sample depicted with a replacement from the training data set. It has been effectively applied to NLP and is useful for text categorization, such as 850 consumer comments on 83 Facebook luxury fashion brand posts, namely used for predicting the negative sentiment. In this case, an R package (RTextTools) for automatic text classification that uses machine learning was utilized (Dhaoui et al., 2017).

- **Random Forest**

The random forest model is utilized principally for classification and regression analysis. It undergoes the stage of organizing various decision trees, using the ensemble learning method, and conducting classification to carry out learning with mean predictive value. In this case, this algorithm was required, among other machine learning techniques, for a study on sentiment analysis based on data on Twitter (800 reviews on SNS from 2014 until 2016) about how satisfied customers are with the service and information supplied by each public institution (Lee et al., 2019).

- **K-nearest neighbor (k-NN)**

Given a positive integer k and a point A, the KNN classifier first identifies k points in the training data most like A. Then, it estimates the conditional probability of A being in class j as the fraction of the k points whose values belong to j. The optimal value for k can be found using cross-validation. This algorithm in an article appears connected to the classification problem in email content detection, like filtering the email spam of email service providers (Hassani et al., 2020) (Lin, 2019).

- **Decision trees**

This algorithm is considered a white-box model since it is possible to infer his behaviour. A binary branching structure is used to classify an arbitrary input vector X. Each node in the tree includes a simple feature comparison against some field. The result of each comparison is either true or false, which determines if we should continue along to the left or right child of the given node. Among other techniques, this one was applied to inspect more than 1 million English tweets collected from GitHub, Kaggle repository, and Twitter 140 API to predict the direction of the sentiment presented on them (Abd El-Jawad et al., 2018) (Lin, 2019).

- **Naive bayes**

The NB is another type of white-box model, and it learns the probabilities based on prior distribution across classes from the training data, considering that all the features are independent. In the case when the prediction of a class is based on training, it is accurately true. It was performed for classification in NLP in an automatic machine translation system developed by IBM, named "Candide", for context-sensitive modelling. It was also tested to analyze the speech of a determined United States (U.S.) presidential candidate from 1996 – 2016 to predict his political party affiliation, region and year in which the speech was given (Hassani et al., 2020).

- **K-means**

Unsupervised learning is a subset of algorithms in AI that does not need any prior training and can be used for clustering and segmentation of information. Particularly while using the K-means method, it can divide any n number of assertions into K clusters, calculating the means between elements iteratively. This algorithm was performed to do a marketing segmentation on the output of Google Cloud Vision of 913 images on Instagram, namely the description, the comments, likes, and location, that contain the hashtag #thegoodlife. Not only to better understand user behavior, but also to better target the desired audience, the segmentation resulted in 14 clusters (Marius et al., 2018).

- **Hierarchical clustering**

The hierarchical clustering algorithm is most fitted to handle unmarked datasets. This method organizes similar points in a way that the scores in the same group are more alike to each other than those in the other clusters. The study utilized it in a random sampling of information from around 200 posts collected from Facebook to evaluate the emotions of Filipinos involved in social media e-Participation and create a codebook, where a corresponding theme/category from the eight topics that arise from the clustering model is assigned to a group (Pitogo & Ramos, 2020).

- **Applicant Tracking System (ATS)**

The integration of an AI software solution into the ATS is possible and can bring benefits, like automating everyday tasks. When applicants upload their resumes, the curriculum vitae parser automatically transfers the data to pre-structured data fields in the applicant tracking system. Individual text modules are examined, and the parser recognizes which components must be sent to which data fields based on the typical text modules. Applicants and recruiters save time and effort using this system. For text comprehension, advanced parsing algorithms use ANNs and deep learning methods (Laurim et al., 2021).

Similarly, it can also be developed an ATS system, that instead of asking for uploading the CV, can ask for upload the necessary documents and check individually if each field is valid, according to the requirements of Police Forces.

4.4.3. Research gap discussion

The SLR analysis concluded that the main research gap is related to the election of the AI technologies that best fit and present a better performance to solve the different problems announced within a Public Contest in the Police Force Institution's scope. It aims to accelerate an evolving process that is still ongoing. Consequently, it will be shown how the suggestions presented in the TO-BE model (Figures 18 - 24) improve the evaluation and selection in the recruitment process for a Police Institution once the adequate talents are selected rigorously and efficiently.

5. AI-BASED THEORETICAL FRAMEWORK FOR THE RECRUITMENT PROCESS

This chapter will confer the assumptions made, the problems identified that compose the theoretical framework, and the AI-based theoretical framework itself. Then, the results of the candidate's segmentation that applied to the Public Contest held in 2019 are presented. A sub-chapter displays the use case that is a real example of the recruitment process of *Polícia Judiciária*, suggesting prescriptive models (TO-BE diagrams). Later, the respective evaluation realized by the experts of those diagrams and the discussion of the advantages and disadvantages related to those is clarified.

5.1. ASSUMPTIONS

This section exhibits the summary of the findings of this research study and the final evaluation according to the experts' opinions. Based on the information transmitted through the interviews with the experts, some problems were pointed out in the framework. The technologies that might reduce the likelihood of those problems' existence are explicit there as well, and the artifact follows the same structure as Figure 2 of another research paper (Lee et al., 2019).

5.2. PROBLEMS IDENTIFIED

The problems pointed out through the semi-structured interview by the expert (President of the Jury), described in the third chapter (3.3.1. Identify the gaps associated with those phases), correspond to the gaps found during the entire recruitment process over the five phases, and are the starting point for improving it. Knowing this, the problems identified are the following:

- The lack of electronic platform functionalities (the platform was not designed to track the full recruitment process from start to finish, which indicates that the information system is not automated);
- Profiling the candidates (detecting the identical characteristics shared between the candidates while belonging to the same cluster. The segmentation is elaborated with the quantitative dataset provided by *Polícia Judiciária* related to the candidates of the last Public Contest held in 2019);
- Interview phase (understanding the facial expressions that undercover the corresponding emotions is crucial, and being able to perceive the personality traits of the candidates in the last evaluation phase, as well);
- Sentiment analysis model for social media (analyzing social media platforms, their content and specifically the sentiment attached to the sentences that were exposed online to ascertain that the candidate presents ethical and deontological principles aligned with the values of the Institution).

5.3. AI-BASED THEORETICAL FRAMEWORK

Evaluation and selection problems of candidates who apply to Public Contests are paired with applicable AI technology solutions, in the conceptual framework below (Figure 17). It depicts the relationship between the challenges during the recruitment process in any Criminal Police Forces and the answers provided by AI. The usage of AI tools to support the recruitment process could help reduce the workload involved in the entire process while maintaining the standard of responsibility. Notice that the "X" symbol represents the first option to be followed acknowledged from the SLR, meanwhile the "*" symbol are algorithms suggested that can also fit the purpose.

AI Technologies					Problems of Public Contests in the Evaluation and Selection of Candidates		
					Profiling the candidates	Interview phase (facial emotional recognition)	Social media insights
AI Technologies	Lexicon based Approach	Dictionary based Approach					*
	Machine Learning Approach	Supervised Learning	Black box models	ANN		X	*
				SVM			*
				Bagging			*
				Random forest			*
				KNN			*
			White box models	Decision trees			X
				Naive bayes			X
		Unsupervised Learning	Clustering	K-means	X		
				Hierarchical clustering	X		

Figure 17 - AI-Based Theoretical Framework

As explained in the fourth chapter (4.4.2. Conceptual solutions), AI Technologies are the ones that tackle challenges encountered during the evaluation and selection phases in the recruitment process of public contests while developing programs that can assist and act quickly. The chosen algorithms are explained below:

- K-means or Hierarchical clustering: these two unsupervised models allow the performance of clusters in a dataset. This means that the Institution can understand and infer which are the similar characteristics their candidates share between them, after carefully selecting them at the end of the recruitment requirements process being assessed through the screening stage;

- Artificial neural networks: through the CNN implementation, a type of ANN, it will be possible to create a new automatized step in the 5th phase, the interview, transforming it into an AI-assisted interview supported by facial emotional recognition;
- Decision trees or Naive bayes: these two supervised white models can be a solution for interpreting the sentiment analysis presented on the social media platforms of the Police Forces Candidates and to obtain more insights in a new step after the interview in the 5th phase. Being aware of the candidate's sentiment, and discovering how they feel about any topic that they have written or shared on their social media accounts, can be measured. In case it is not relevant to demonstrate the behaviour of the models applied to their candidates, from the Institution's perspective, black models are also a possibility.

5.4. SEGMENTATION OF THE PUBLIC CONTEST CANDIDATE'S HELD IN 2019

In order to help the *Polícia Judiciária* analyse and cluster their database of all candidates a segmentation was performed. The methodology selected to conduct this data mining project followed the CRISP-DM particular approach (Chapman et al., n.d.).

For this project, the provided sample of 2399 candidates from the active database of the *Polícia Judiciária* was used, which referred to the ones who applied to the National Public Contest held in 2019. The dataset has 2399 candidates and six features.

Understanding the characteristics and behaviours that best describe and discriminate the applicants by analysing their sociodemographic information and data from the Institution is one of the main goals. Another goal is, with the use of unsupervised machine learning techniques, to achieve the segments of the Institution applicants.

The first step was to load the data from an excel file into a Jupyter Notebook, an open-source software (*Project Jupyter*, n.d.). When analysing the type of variables that were given, it stands out only one was an integer, the rest were categorical.

After looking at the summary statistics of all the features and checking for missing values and duplicated data, the conclusion is that there were no missing values or incoherencies. Although the duplicates rows existed, they were not discarded since there exists a high likelihood of a candidate having the same gender, age, educational level, studying the same, and living in the same place as another one.

The cleaning step was fundamental to drop all the rows which could negatively affect the dataset and consequently the analysis. The "Age" variable had values above 30 years old, which according to the specific recruitment requirements in criminal investigation and security careers in *Polícia Judiciária* under the Decree-Law No. 138/2019 Article 44.º (*Decreto-Lei n.º 138/2019 | DRE*, n.d.), it is not possible, so 54 rows were dropped due to that reason. The "Nationality" variable presented many unique values which were misspelt, and these were replaced by the correct word "Portuguesa". Illogical unique values and two nationalities different from the Portuguese (Spanish and Canadian) were dropped from the dataset according to the general recruitment requirements in any *Polícia Judiciária* career under the Decree-Law No. 138/2019 Article 44.º (*Decreto-Lei n.º 138/2019 | DRE*,

n.d.) possessing Portuguese nationality is indispensable. Both variables, "Gender" and "Educational level", did not present any noise.

Concerning the variables "Study area" and "Place of living", both conferred an extensive quantity of unique values and illogical unique values, which were removed. This way, two new columns were constructed for grouping and summarizing the old values. The new "Area" column created followed some guidelines, generating eight categories: Law category: included law and solicitor; Social category: included social sciences (sociology and psychology) and humanities; Science category: included all types of sciences; Business category: included business, management, and economics; ICT category: included any type of engineering and information and communication technologies; Health category: included health, medicine, and veterinarian medicine; Architecture category; and Art category: included performing and creative arts. The new "District" column was the result of grouping every value from "Place of living" into the corresponding Portuguese district, including the islands (Região Autónoma dos Açores and Região Autónoma da Madeira), ending up with 20 values. The other four values coincide with two applicants who live in Switzerland, one applicant in England, and another one in China. Still related to the data construction of the "Nationality" variable, three records wrote Portuguese and another nationality (Spanish, Venezuelan, and Brazilian). These three were replaced by the "Double nationality" string. The final dataset has 2330 candidates and six features (four that belonged to the initial dataset and two new variables).

A relevant step to avoid bias in the results is to check outliers in the numerical features. The "age" variable did not present any outliers because according to the specific recruitment requirements in criminal investigation and security careers in *Polícia Judiciária* under the Decree-Law No. 138/2019 Article 44.º (*Decreto-Lei n.º 138/2019 | DRE*, n.d.) as mentioned above, candidates are restricted to have no more than 30 years old.

The one-hot encoder function was tested on the non-metric features where every single m feature is converted into an m-length vector (Lin, 2019).

Regarding the data format, the dataset was standardized using the min-max normalization approach (between 0 and 1) to ensure that the metric variable did not have a greater impact on the model due to its scale.

The first model to be tested was the K-means algorithm. To find the most effective number of clusters it was used the inertia plot and the average silhouette metric, moreover the algorithm was tested with three clusters. The other model tested was a Hierarchical Clustering over K-means. Initially, discovering what linkage method (ward, complete, average, or single) fitted better by inspecting the plot of the R squared for various hierarchical methods, then the K-Means algorithm was necessary to perform the centroids and plot the dendrogram. Afterwards, the Hierarchical Clustering model was tested with three clusters.

The Hierarchical Clustering over the K-Means model was the one that achieved the best silhouette score. While certain groups could easily be combined, the interpretability of the clusters offered by this approach was acceptable.

The success criteria for the results in machine learning terms was to achieve a silhouette score higher than 0.5, which was reached since the score of the chosen model is 0.54443866. Nevertheless, the K-Means model achieved a score of 0.506779.

The best segments are given by the Hierarchical Clustering over K-Means. Therefore, the major characteristics of the five clusters in terms of social-demographic data (Age, Gender, Nationality, Educational level, Area, and District) are:

- Cluster 0 with 581 candidates

Predominant Portuguese female candidates belong to this cluster. These candidates have approximately 24 years old, and the degree is their highest level of education. The areas of their education fit the Law, Social, and Science categories. They live in the north of Portugal (Bragança, Viana do Castelo, and Vila Real districts), in the centre (Viseu district), in Alentejo (Beja district), in Algarve (Faro district), or in Região Autónoma da Madeira. This regional division of Portugal, also presented in the next clusters, follows the NUTS II ("Nomenclatura das Unidades Territoriais para Fins Estatísticos") criteria established (PORDATA - O Que São NUTS?, n.d.).

- Cluster 1 with 611 candidates

This cluster includes the highest number of candidates, and their age is around 27 years old. Most of them are Portuguese female candidates with a degree. The study areas fit the Law, Social, Health and Art categories. These candidates reside in the capital of the country, Lisboa, in Alentejo (Santarém district), in the centre (Leiria district), or in the north (Braga district).

- Cluster 2 with 482 candidates

These candidates are characterized by being the youngest, around 22 years old, and the majority are Portuguese female candidates. Surprisingly it is the only cluster that has a master's degree in areas like Business, Science and Social, even though of their age. This might mean that these candidates after succeeding in their degree applied to a master's without any scholarly interruption. They are located in the north of Portugal (Braga, Bragança, and Porto districts), in the centre (Leiria, Castelo Branco, and Viseu districts), and Alentejo (Beja and Portalegre districts), or outside the country in England.

- Cluster 3 with 303 candidates

This cluster includes the lowest number of candidates. These candidates are characterized by being the oldest, around 29 years old, and the majority are Portuguese male candidates with a degree. Their study areas fit the Law, Business, or ICT categories. They are scattered across the country, they reside in the capital, Lisboa, or Setúbal, or in the centre (Coimbra and Guarda districts), in the north (Bragança district), in Alentejo (Santarém and Évora districts), or the Algarve (Faro district), in the island (Região Autónoma dos Açores), or even outside the country in Switzerland and China.

- Cluster 4 with 353 candidates

Very similar to cluster 1 but with prevalent Portuguese female candidates around 26 years old. They have a degree that fits the Law and Social categories. They live in the two most populated districts in Portugal, Lisboa and Porto, or Braga, or Leiria.

The dataset reaches the quality required for the modelling step after performing exploratory analysis, extracting valuable insights from it, and cleaning it.

As a result, K-means and Hierarchical Clustering over K-Means were used as cluster methods. The major goal was to use silhouettes and dendrograms to find the optimal combination.

The Hierarchical Clustering over K-Means model, with a final solution of 5 clusters, was chosen. Due to their commonalities, clusters 1 and 4 could be merged.

In the end, the Institution will reduce the costs associated with the ineffective analysis of its candidates, meaning that the target of future Public Contests will be understood and fulfilled the needs of the Institution. Through the use of these algorithms, such as Hierarchical Clustering, K-Means, will obtain groups (clusters) composed of similar applicants that based on their behaviour and features, are as dissimilar as possible from the applicants in the other groups.

5.5. USE CASE

The "TO-BE" diagrams for each identified process will be provided in the following sub-chapters. These are prescriptive models that suffered a redesign from a single candidate perspective of the recruitment process. This redesign followed some guidelines, namely Heuristic 9, as explained in the third chapter (3.3.2. Integrate a new procedure into the current recruitment strategy). The TO-BE diagrams were performed with the previously mentioned tool for visualizing, modelling, documenting, and simulating business processes, Bizagi Modeler (*Bizagi, One Platform; Every Process. User Guide Modeler*, n.d.).

5.5.1. Process "Check the general and specific requirements" – TO-BE Diagram

The redesigning of the "Check the general and specific requirements" process (Figure 18) resulted in a diagram with only one more step, however, it is more efficient and saves time due to the initial automatization of the recruitment process provided by the ATS (Applicant Tracking System). This way, the system receives every registration and proceeds with the screening stage sub-process. After the screening, the new step added before concluding the process is related to the profiling of the candidates, who have so far been accepted. Applying a clustering algorithm as suggested in the framework will allow the Institution to discover how many clusters are formed, how many elements belong to each one, and what are the characteristics shared between them- age, gender, nationality, education level or area, or even place of living. The activities associated with the Jury maintains the same, and the HR department is only in charge of certificating the reclamations.
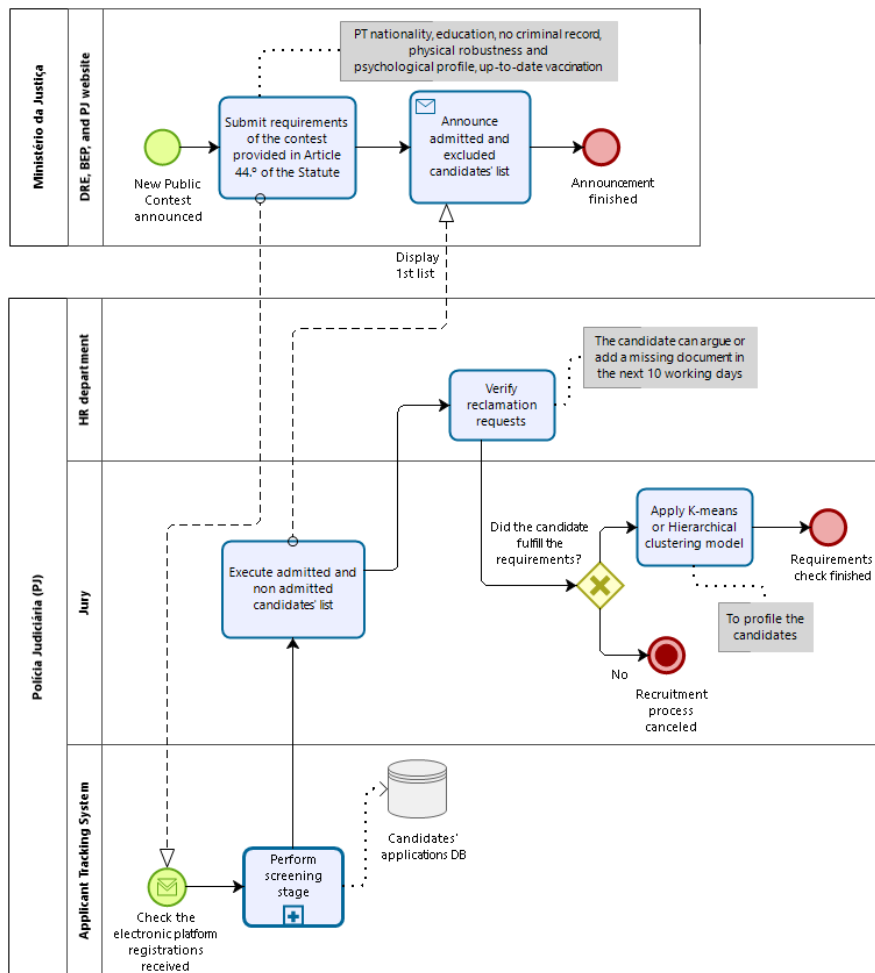

Figure 18 - Check the general and specific requirements – TO-BE Diagram

5.5.2. Sub-process "Screening stage" – TO-BE Diagram

Sub-process "Screening stage" (Figure 19) is a detailed description of each parameter that is verified during the process "Check the general and specific requirements" (Figure 9). Initially, it was developed by the HR department, although the suggestion is to start being performed by this new system. After the documentation is received, all the parameters for any PJ career and special careers as well are assessed. Furthermore, the dates of each document will be validated, or if there is any repeated document uploaded by mistake. The parallel gateway allows the continuation of the next activity ("Evaluate the results"), if and only if every parameter is according to the established under the Decree-Law No. 138/2019 Article 44.º (*Decreto-Lei n.º 138/2019 | DRE*, n.d.).
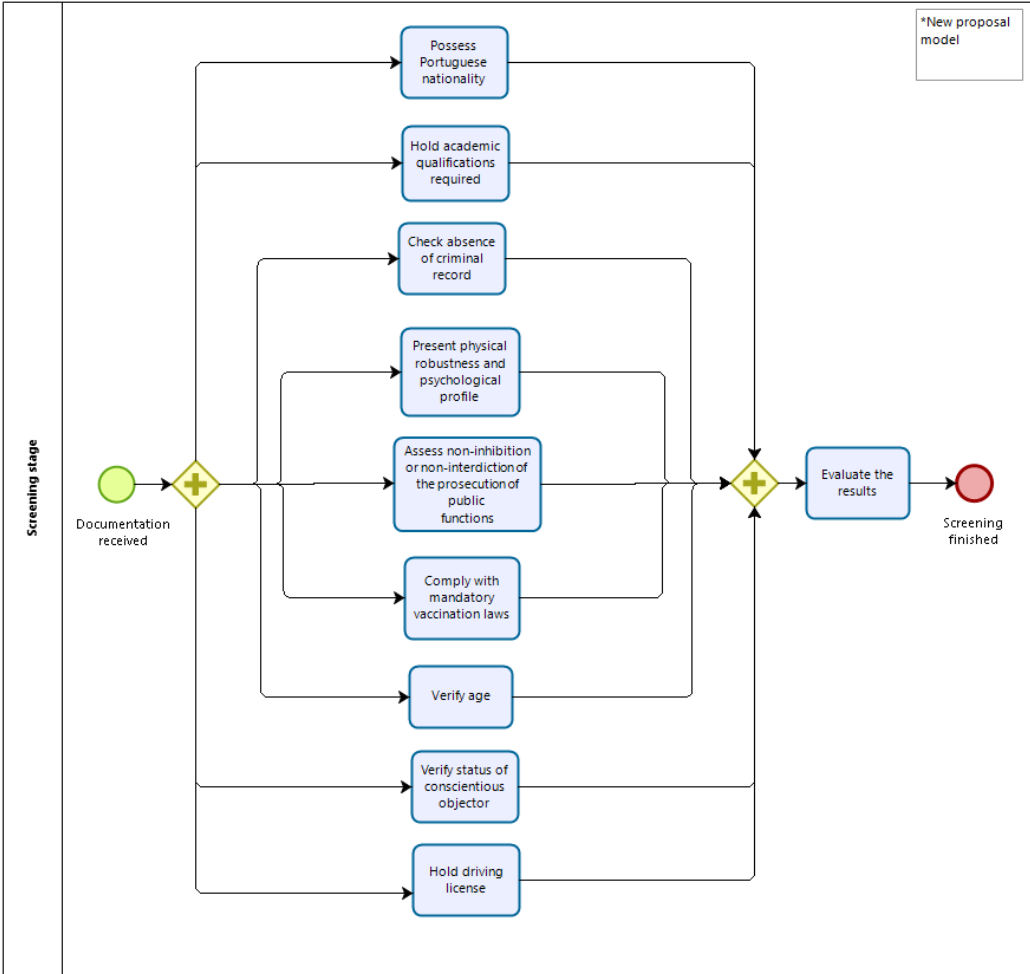

Figure 19 - Screening stage – TO-BE Diagram

5.5.3. Processes "1st phase, 2nd, 3rd, and 4th of the recruitment process"– TO-BE Diagram

The following figures (Figures 20 - 23) did not suffer any alteration according to the guidelines explained by the experts in the semi-structured interviews. Thus the "1st phase of the recruitment process" (Figure 20) is executed by the same performers, and no further activities were added.
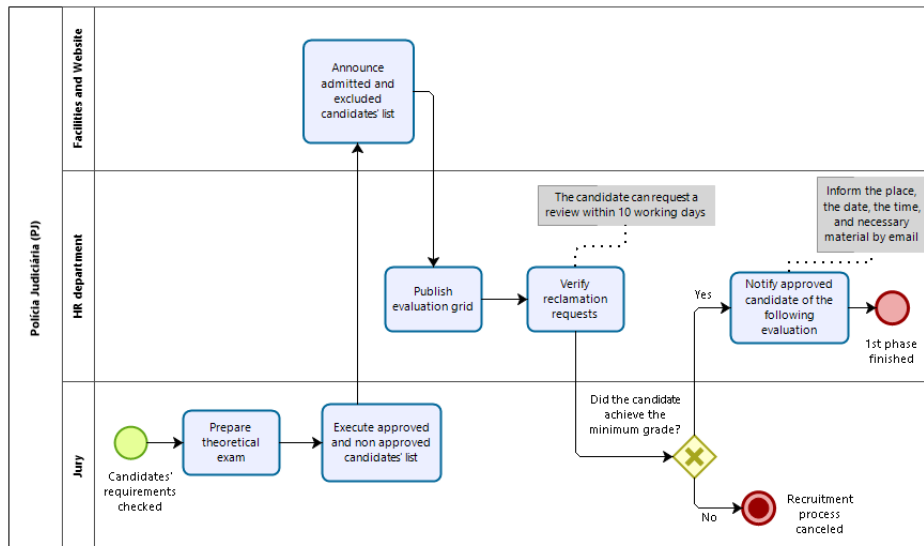
Figure 20 - 1st phase (theoretical exam) – TO-BE Diagram

The "2nd phase of the recruitment process" (Figure 21) is executed by the same performers, and no further activities were added.

Figure 21 - 2nd phase (physical evaluation) – TO-BE Diagram

The "3rd phase of the recruitment process" (Figure 22) is executed by the same performers, and no further activities were added.

Figure 22 - 3rd phase (psychological evaluation) – TO-BE Diagram

The "4th phase of the recruitment process" (Figure 23) is executed by the same performers, and no further activities were added.
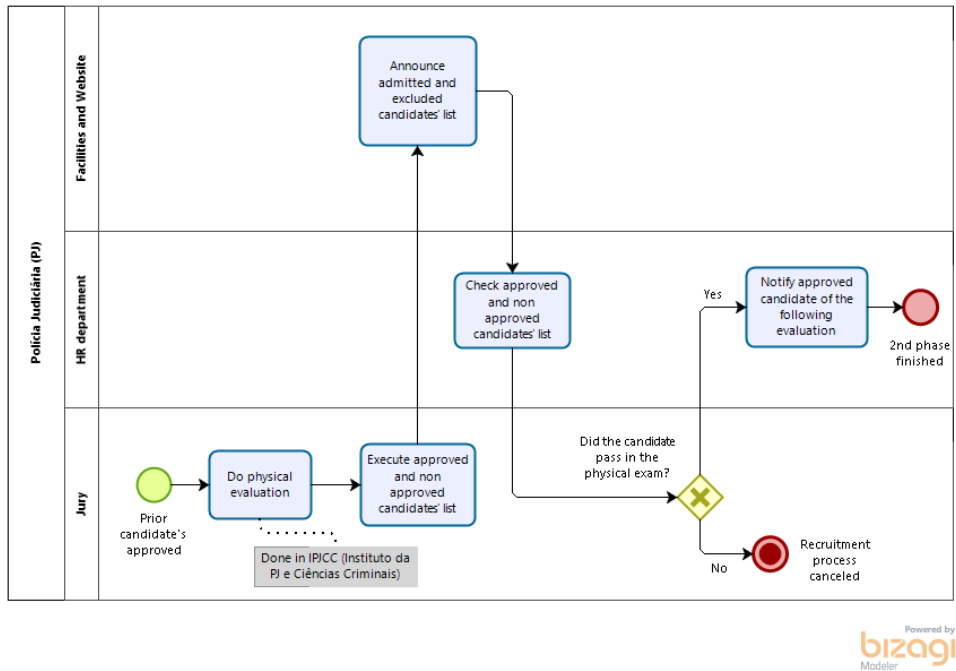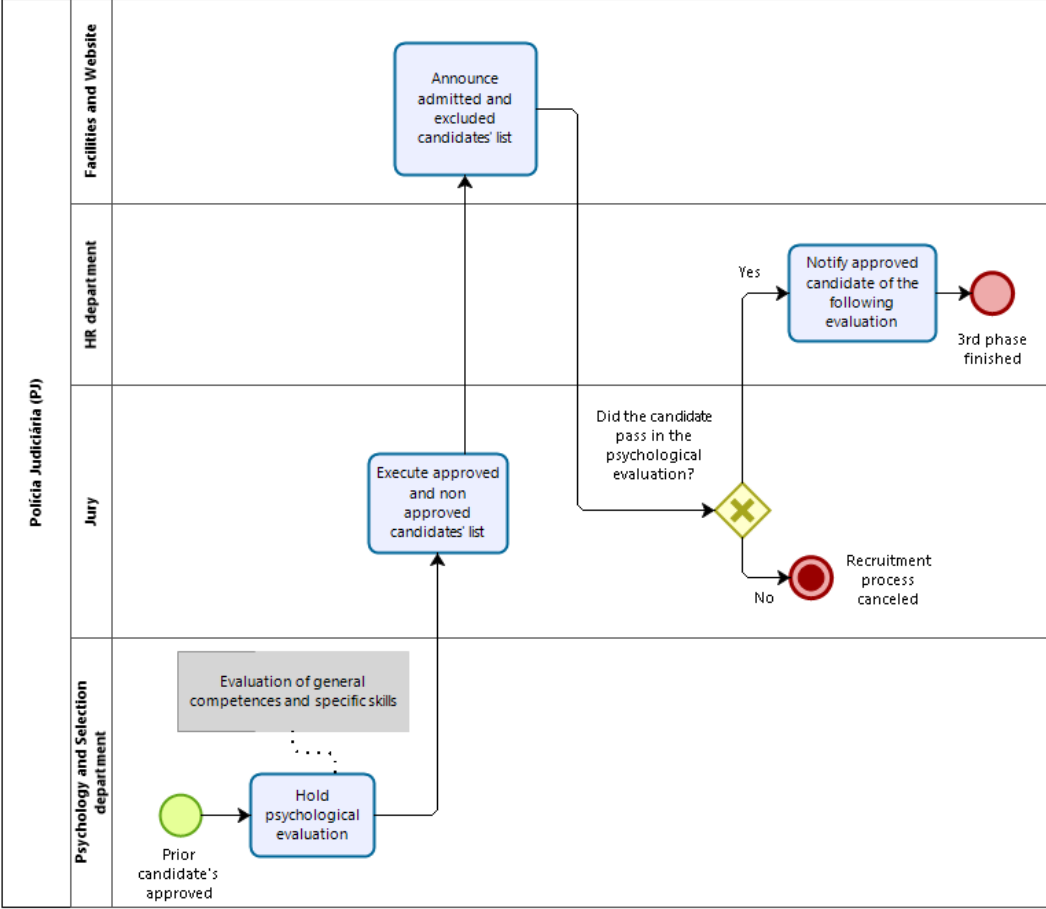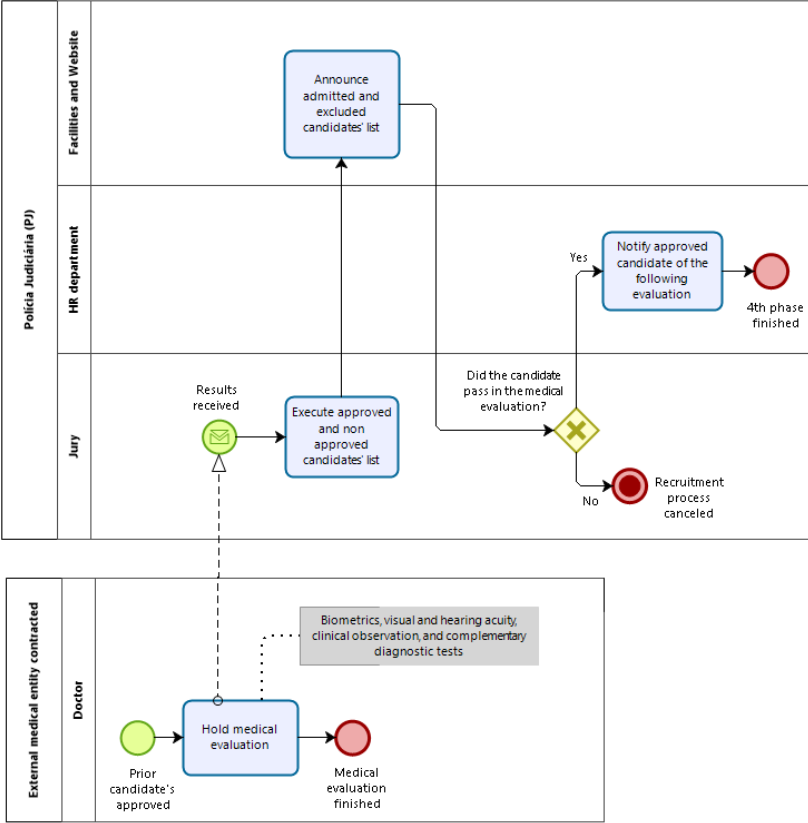

Figure 23 - 4th phase (medical evaluation) – TO-BE Diagram

5.5.4. Process "5th phase of the recruitment process"– TO-BE Diagram

In the "TO-BE" diagram for the process "5th phase of the recruitment process" (Figure 24), the parallel gateway will connect the presential interview in the presence of the Jury and the AI Tracking System. This way obtaining a more accurate version of the candidate's traits is possible due to the AI-assisted interviews. Immediately after, the system will investigate the social media accounts of the candidates with the help of models that perform sentiment analysis. Lastly, it is possible to select every candidate that presents ethical and deontological behaviour either face-to-face or on their social media platforms. The candidate can then proceed and will be part of the final list.
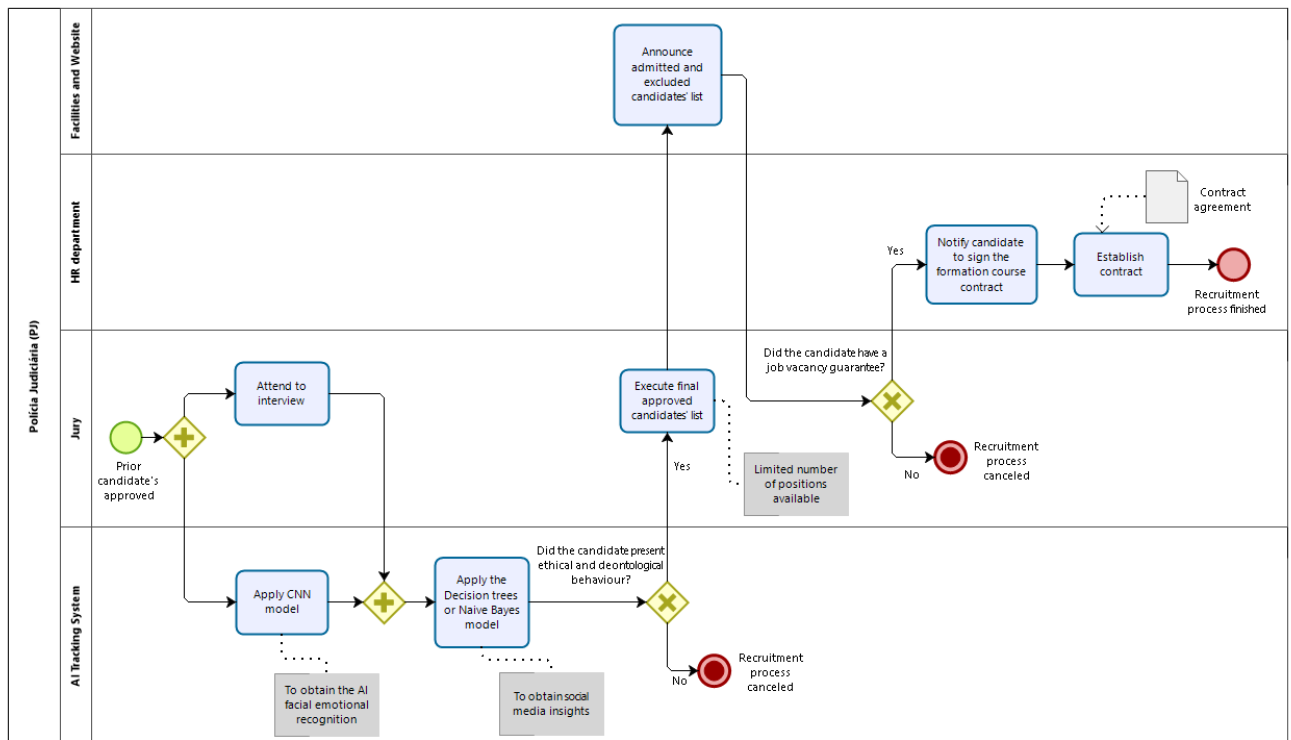

Figure 24 - 5th phase (interview) – TO-BE Diagram

5.6. EVALUATION

Validation is essential after producing the "TO-BE" diagrams and the elaboration of the AI-based theoretical framework, and this was accomplished through a one-on-one semi-structured interview in the presence of the President of the Jury. Due to this, four questions were asked:

- Do you agree with the proposed modifications presented in the "TO-BE" diagrams? If not, which of the modifications do you disagree with?

The expert agreed with the proposed suggestions, namely with the ATS (Applicant Tracking System) lane and the segmentation activity, both in the Process "Check the general and specific requirements". As well as with the AI-assisted interview and the sentiment analysis activities in the Process "5th phase of the recruitment process". No further comments were added related to this topic.

- Do you believe that the proposed modifications are sustainable/feasible? If not, which one of them do you consider unsustainable/unfeasible?

The expert mentioned that mainly changing the current system used in *Polícia Judiciária* into the new system suggested (ATS) would be value-added. For the reason that the ongoing system does not follow the entire process of verification of the requirements (neither general nor specific), does not inspect the expiration date of the documents or if by mistake they were uploaded repeatedly. All the other three modifications the expert sees them being sustainable and feasible.

- Do you have any suggestions/ comments for modifications?

Regarding the comments that the expert considered about the application of the unsupervised machine learning models activity to profile the candidates, she suggested that it can be before the last phase (5th phase), instead of being at the end of the Process "Check the general and specific requirements". So the jury has at their disposal the characteristics shared between applicants who got accepted until the 4th phase. And related to the AI-assisted interview, privacy issues were claimed with respect to the recording need further clarification from a candidate's perspective, for instance, if they allow their image to be recorded or not.

- Would you support the implementation of these modifications?

The expert confirmed that she supports the implementation of the suggested modifications, adding that if well implemented can turn the recruitment process efficient.

5.7. DISCUSSION - ADVANTAGES AND DISADVANTAGES OF THE CONCEPTUAL FRAMEWORK

Finally, to evaluate how prone are the Police Forces currently to implement and use this type of technology, subsequently, the interview was conducted in the last phase of the research. Taking into consideration another research study (Wesche & Sonderegger, 2021) and the general opinion of the experts, the advantages and disadvantages of implementing AI in the evaluation and selection phases of the recruitment process in *Polícia Judiciária* are the following:

Table 8 – Advantages and disadvantages of the framework

Pros	Cons
Combination of AI and human decision making	Lack of capabilities
Fair, objective, and unbiased procedure	Missing human factor
Efficiency and speed	Lack of control and possibilities to perform
Innovative and modern	Lack of explanation
Convenient and stress-free	Missing inclusiveness

The combination of AI and human decision making indicates comments expressing positive attitudes towards a selection process in which decisions in the screening stage are taken by an AI while a person conducts the interview with the support of AI. It is a fair, objective, and unbiased process that emphasizes a decision-making process that is free of nepotism and favouritism when carefully developed. Efficiency and speed reflect the statements indicating the efficiency and time-saving of adopting a more automated recruitment process. Innovative and modern as a category groups the statements that emphasize the innovative and modern nature of the process. And finally, convenient and stress-free summarizes statements expressing a favourable attitude towards the employment of AI because of the process's simplification and the decrease of stressful experiences during the assessment situation.

On the other hand, the negative aspects pointed out, an eventual lack of capabilities summarizes the doubts that were expressed regarding the ability of AI to make such decisions acceptably. Missing human factor refers to the perception that an AI-assisted/ automated selection procedure lacks the human touch or personal element that is deemed crucial in personnel selection. Nevertheless, in our case, the recruitment process has this combination in the 5th phase. Lack of control and possibilities to perform beliefs that there is less chance to laboriously influence decision-making in the context of automated personnel selection. Lack of explanation emphasizes the participants' concerns about not having enough knowledge and comprehension about how the automated selection procedure operates and makes decisions, which could be reduced when applying white-box models instead of preferring black-box models. Lastly, missing inclusiveness is the category describing concerns about potential prejudice, like discrimination, against certain groups of individuals as a result of automated selection procedures.

6. CONCLUSIONS

In this work, an analysis of the recruitment process of a Police Force Institution was performed and based on that an innovative AI-based theoretical framework was constructed. This framework expects to improve the evaluation and selection in the recruitment process while suggesting some new AI technologies to the National Criminal Investigation Police agency of Portugal – *Polícia Judiciária*.

This dissertation was developed with the purpose of improving the recruitment process by always taking into consideration the ethical and deontological values of the Institution, among them fairness, transparency, and accountability.

Both research questions were answered through an investigation in the field supplemented with the existing literature. RQ1: "What are the most important facts facing Public Institutions regarding the usage of AI technologies to make decisions about evaluating and selecting candidates?", semi-structured interviews were conducted with the experts to understand specifically the existing gaps in the selection criteria of the Public Contests that are in vigor in Police Forces.

Regarding the second research question, RQ2: "How can the usage and exploitation of transparent AI have a positive impact on the recruitment process of a Public Institution?", this question was answered while reading and comprehending other scholars' work in the same field. The most used AI tools were pointed out according to their specific contexts.

Conjugating the results of both research questions helped to elaborate the framework, on one hand, the gaps found that deal with how to profile the candidates; how to obtain more accurate information from the interview phase; and how to gauge a more complete picture of a candidate social media profile; on the other hand, the AI tools found in the SLR. These are indicated for solving them and minimizing their lack of understanding.

In conclusion, it got proved that the Public Sector can improve its service while making transparent decisions that are more automated and efficient while saving time. Ensuring at the same time an enlightened combination of AI and the human factor.

There are two main limitations in this study that should be considered. First is the difficulty regarding the timetable, privacy, and legal issues associated with Public Institutions. This type of research study needed to follow the established deadlines, and because of some bureaucracies and law topics, it was revealed to be complicated. Second, a small group of experts served as the validation group for the new framework. Individual semi-structured interviews were conducted to alleviate this constraint, as they provide additional insights into an interviewee's opinions, beliefs, and points of view, and the advisors interviewed were chosen based on their expertise and relationship to the thematic, influencing several aspects of the process.

As a future research topic, the expert, the President of the Jury, referred that one of the recruitment process gaps concerns the electronic platform. The information system which receives the applications presents a lack of automation associated once it does not follow the entire process from the beginning until the end. Additionally, she also mentioned that AI would be useful to the Institution if it could independently check the applicant documents and if they are up-to-date. In case it is necessary, requests the new information from the candidate.

The screening stage is the initial selection stage and is defined when the organizations pre-select applicants based on the evaluation of their application documents (Wesche & Sonderegger, 2021). This way, a suggestion for future research is to study a possible implementation of an automated recruitment system meaning an AI recruitment system in a Police Force context, to address the current gaps.

The main concern is to ensure that the system is fair, transparent, and facilitates their application process.

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APPENDIX

No âmbito do Mestrado em Data Science and Advanced Analytics, na NOVA IMS, o propósito desta tese é perceber como é que a Inteligência Artificial pode vir a melhorar a avaliação e seleção de Candidatos nos Concursos Públicos, especificamente na *Polícia Judiciária*.

O objetivo é entender a perceção dos candidatos sobre uma monitorização de como interagem e se comportam nas redes socais.

O contributo final do estudo será obter uma avaliação mais rigorosa da sua inteligência emocional e um alinhamento de valores éticos, políticos e sociais de acordo com os valores da *Polícia Judiciária*.

O questionário irá durar aproximadamente 3 minutos, e as suas respostas serão anónimas e somente utilizadas para a análise em questão.

Obrigada!

Questão de exclusão de target

1) Foi candidato ao curso de Inspetor Criminal na Polícia Judiciária em 2019?

Demográficas
1) Faixa etária
2) Género
3) Está registado em alguma plataforma de rede social?

Geral

1) Em que redes sociais se encontra registado?
2) Considera-se um utilizador ativo que comenta, publica e partilha regularmente conteúdos nas redes sociais?
3) Qual é o tipo de conteúdo que mais coloca "Gosto", partilha ou cria?
4) Em média, quantas horas despende diariamente em redes sociais?

AI no processo de recrutamento

1) Considera que o conteúdo das suas redes socais deve ser tido em conta no processo de recrutamento ou deve ser independente disso?
2) Justifique até que ponto considera que o processo de recrutamento deve ser baseado nessa informação?
3) Já teve alguma experiência com algoritmos de Inteligência Artificial num processo de recrutamento?
4) Como descreve a sua experiência?

Análise de Sentimento

1) Considera que um tipo de seleção baseado na análise de sentimento das redes sociais de um candidato a ser realizado e aplicado consistentemente seria uma boa abordagem?
2) Pensa que o tipo de seleção anteriormente referido seria livre de um eventual enviesamento?
3) Justifique a sua resposta

Obrigada!